# of Men & Rivers

The Story of the Vicksburg District

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Of Men & Rivers

The Story of the Vicksburg District

by

Gary B. Mills

January 1978

U. S. Army Engineer District, Vicksburg
Corps of Engineers
P. O. Box 60
Vicksburg, Mississippi 39180

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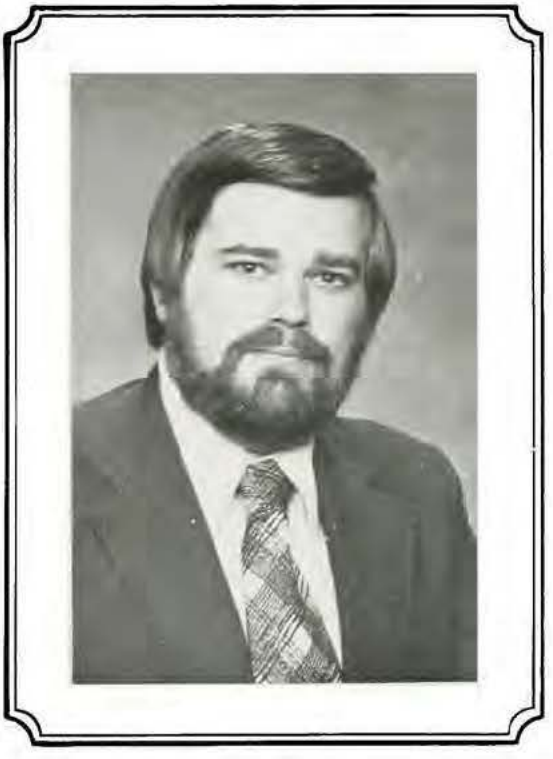
ABOUT THE AUTHOR

Dr. Gary B. Mills is a native of that region served by the Vicksburg District of the United States Army Corps of Engineers. He was born in northeast Texas, before the Red River Basin was transferred to the New Orleans District, and was raised in the Yazoo-Mississippi Delta. An alumnus of Mississippi State University with a doctorate in Southern and Economic History, Dr. Mills is the author of a number of publications on the development of the Mississippi and Red River Valleys, including *The Forgotten People: Cane River's Creoles of Color* published in 1976 by Louisiana State University Press. The author is presently on the faculty of the University of Alabama at Gadsden.



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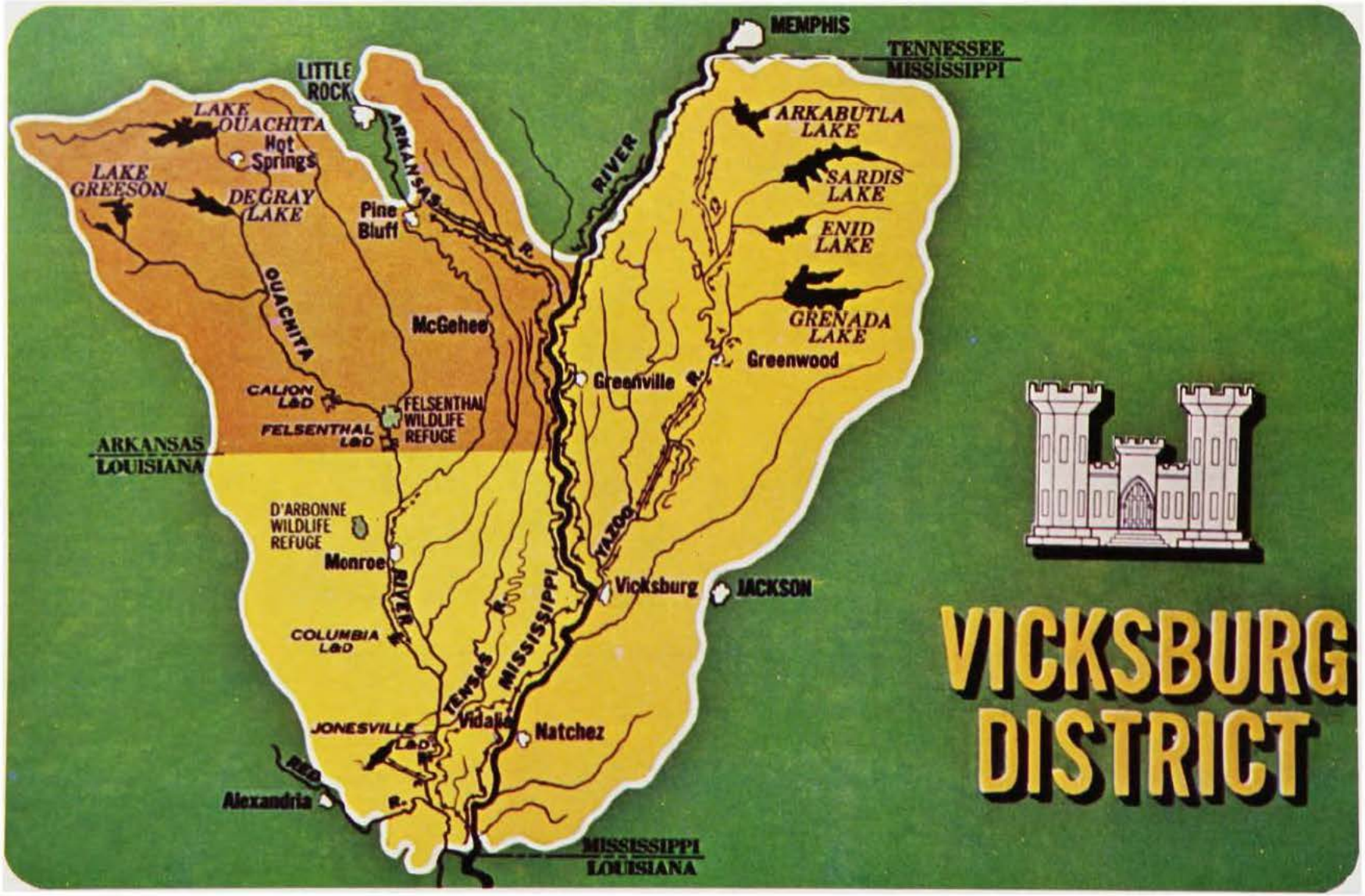
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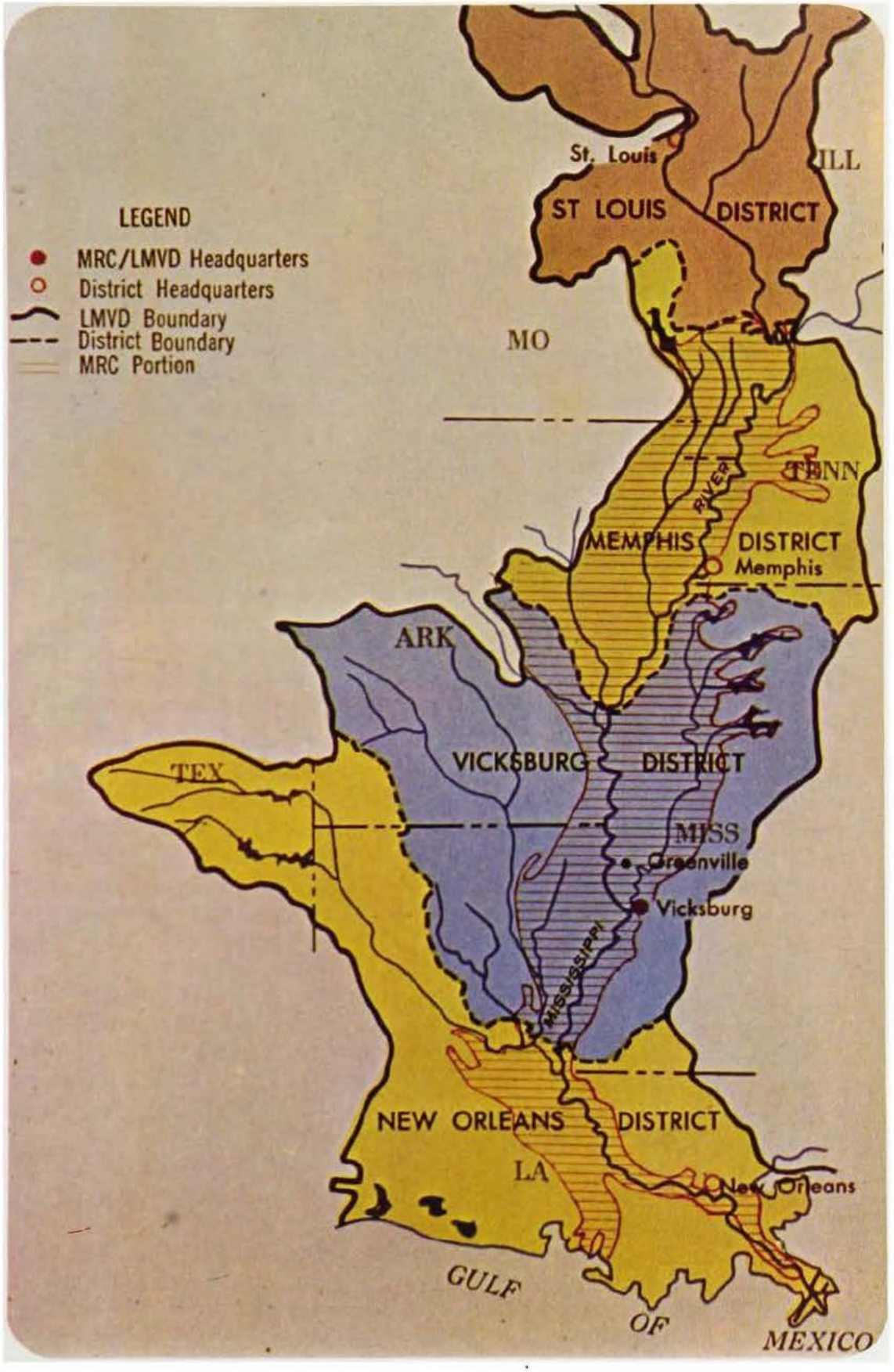
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MRC/LMVD Headquarters
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Greenville
Vicksburg
MISSISSIPPI
NEW ORLEANS DISTRICT
LA
New Orleans
GULF OF MEXICO

INTRODUCTION

For centuries before the U. S. Army and its Corps of Engineers entered into the task of developing the Mississippi River for use of the inhabitants of the lower Mississippi Valley, the Big River contested agricultural advances, industrial efforts, and even the right to live along its banks. Today, however, the river has been converted into a useful navigation and commerce tool with many industrial and agricultural centers spreading behind newly strengthened levees and floodwalls.

This monumental accomplishment is credited in part to the revetment, levees, and other flood-control works and related projects along the Mississippi and its tributaries. The men and women, civilian and military, of the Vicksburg District have been chiefly responsible for the better society we now enjoy in the lower Mississippi Valley. They have given the long, hard hours, endured treacherous river conditions, and even, at times, surrendered their lives in the line of duty.

The history of the Vicksburg District is the story of these people who have accepted great technical and social challenges to keep "Ole Man River" in his place. This document is not meant to describe each and every project and thus contains few statistics, designs, or blueprints. "Of Men & Rivers" is oriented to the past, not the present or the future, and reflects the flesh-and-blood men and women who have given life a chance in the alluvial valley of the Mississippi.

GERALD E. GALLOWAY
Colonel, Corps of Engineers
District Engineer

PREFACE

In all frankness, I must inform the reader that I have tried to be objective throughout the preparation of this study but it has not been easy to overcome an inherent bias.

I was reared within the Vicksburg District on a rice plantation in the Yazoo-Mississippi Delta. I learned early to respect and fear the power of the river that dominated our country. The mammoth levee which stood less than 10 miles away was the only protection our family and neighbors had against the annual fury of the Mississippi. The land we cleared and put into production had been a swampland in the not-too-distant past—and would still be one were it not for the flood protection and drainage works of countless individuals, local government, but mainly the U. S. Army Corps of Engineers.

The Delta I knew as a child has changed drastically over the past two decades, and the work of the Corps of Engineers has definitely influenced this change. Vast stretches of fertile but previously unusable land have been put into production and the quality of life has improved. But many favorite hunting grounds are gone, and I mourn the loss.

It is impossible to make a value judgement between the old Delta and the new, but it must be recognized that the vast belts of timber marshes in the old Valley served only those who were strong enough to invade them while the cleared, drained, and fertile fields that have replaced them are being touted as tomorrow's "Bread Basket of the World."

The 13 months that I have spent in the preparation of this History of the Vicksburg District, U. S. Army Corps of Engineers, have been challenging ones. As a Delta native and a Southern historian, I thought I was already familiar with the basic work of the Corps in the Mississippi Valley, but I had much to learn. Over the decades, the scope of their work has undergone a number of significant alterations, and I speak not only of geographical changes but also of revisions in the duties and responsibilities assigned the Corps by a rapidly changing Nation.

Even in 1976, the Bicentennial year, with its focus upon America's past, there were still many who asked, "Why such concern with *history*? The past is gone and cannot be changed. Our emphasis should be on the future, and our skills and resources should be directed toward solving the Nation's problems." But those who pose such questions, it seems, have not understood the real significance of that momentous year. America's Bicentennial was not merely a long victory celebration; ideally, it was a rebirth, a reappraisal, a soul-searching evaluation of our accomplishments and failures, so that we might more effectively plan our future. For this purpose, history is indispensable.

In essence, history is a study of man and his activities—both his achievements and his mistakes. Unlike mankind, however, history is never finite; rather, it is a pulsating, fascinating, ever-growing exploration of society. The discovery of our national character will never be made in one momentous event, but by a slow, methodical, and scientific process in which each facet of society is analyzed, summarized, and made known. This post-Bicentennial History of the Vicksburg District of the Corps of Engineers is one such base upon which any comprehensive history of our Nation can be built.

The United States Army Corps of Engineers is a military branch of the United States of America, and its military activities over the past 200 years have been frequently studied by historians. The responsibilities of the Corps of Engineers, however, are far broader than its name implies. The domestic civil activities of the Corps have been—and still are—indispensable to the growth of our Nation. Yet, neither the public nor the scholar thoroughly understands the civil mission of the Engineers and their contribution to American society.

Within the Corps organization, the Vicksburg District is unique. It is among the largest of the districts, and among the oldest as well. More significantly, its mission throughout this century of service has been overwhelmingly civil in scope. Emphasis upon military construction, such as occurred during World War II, has been rare.

In synopsis, the overall mission of the Vicksburg District has ranged from improvement of navigation to flood control, to military preparedness, to disaster relief, and to life-quality improvement. This study of the Vicksburg Engineers will provide a broad spectrum through which the overall activities of the Corps can be viewed.

In compiling this history, efforts have been made to produce a grass roots study which is as comprehensive and human as its inherent limitations of time and space will permit. Yet, in covering the numerous undertakings of the Corps, it is impossible to discuss each work and every one involved. Consequently, the more significant projects have been chosen as examples of the overall work, while the missions selected reflect the interests and concerns of the public, the perspectives of historians, and the values of civilian and military engineers.

The nature and availability of materials have further influenced the focus of this history. Only a minimal number of documents exist for certain periods of the District's activities, and an infinitesimal number are available on other periods. The material preserved from earlier years, for example, is often delightfully personal in nature, while the material preserved in more recent years (due to the unprecedented growth of the organization's responsibilities) has been necessarily limited to more technical data. Hence, we have a much better understanding of the character of the early Engineers than that of the more familiar Engineers of the twentieth century. However, all aspects of the District's history can be studied in greater depth by anyone who wishes to explore the voluminous files of the Corps and the hundreds of thousands of linear feet of microfilmed documents that have been made available to scholars and public alike.

CONTENTS

ACKNOWLEDGEMENTS

The completion of so complex a study in so limited a time would never have been possible without the generous assistance of many individuals. Their technical advice, their resource contributions, their fascinating anecdotes are sincerely appreciated and have been extremely valuable to me in understanding the mission of the Vicksburg District. I regret that time and space limitations have forced me to edit many contributions from the final draft.

The assistance of Colonel Gerald E. Galloway, under whose administration this history was written, has been invaluable. In the months that this project has been under way, Colonel Galloway has made every effort possible to facilitate my work. Lieutenant Colonel Clifford W. Steelman, Deputy District Engineer, has likewise opened doors for me during the absence of his commanding officer. Special appreciation is due to Mr. Udelle T. Jones, Chief of the Office of Administrative Services and Chairman of the District Historical Committee, and his assistant, Mrs. Rita G. McCain.

The Mississippi River Commission Library, staffed by Mrs. Betty R. Johnson, Librarian, and her able assistant, Mrs. Mary H. Hall, supplied much aid and advice. A similar debt of appreciation is owed to the efficient librarians of the U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi, particularly to Messrs. Charles Lieux and Donald J. Kirby, to Mr. Gayle Peters of the Atlanta Federal Archives and Records Center, and to the staff of the National Archives for extensive efforts to locate obscure papers and ledgers dealing with the Vicksburg District.

The Historical Division of the United States Army Corps of Engineers provided much advice on the location and treatment of various Engineer records. Many thanks are due their historians, Drs. Jesse Remington, Lenore Fine, Charles Walker, and Bert Cowdrey.

A note of appreciation must also be made to the Public Affairs Office of the Vicksburg District for their help in locating records within their extensive files, particularly to Mr. Billy C. Bridges, assistant to the chief of the Public Affairs Office, Mrs. Peggy P. Holliday, Editorial Clerk, and Mrs. Helena C. Walley, Public Information Specialist. Michael H. Logue, writer-editor for the Public Affairs Office, edited and selected photographs for the final manuscript while serving as technical liaison between the publishers and District officials.

The many maps furnished by Mr. John W. Hodge, Jr., of the Map Sales Section, Vicksburg District, greatly assisted me in putting the documents in their proper perspectives.

The staffs of the Mitchell Memorial Library at Mississippi State University, the Howard-Tilton Memorial Library at Tulane University, New

Orleans, and the New Orleans District Library have also given generously of their time. The Library of the United States Military Academy, the Mississippi Department of Archives and History, the R. W. Norton Art Gallery, the New York Historical Society, and the Library of Congress were of much assistance in locating old photographs.

The Department of History at Mississippi State University supplied much assistance throughout the bulk of the period during which work was in progress. A similar word of appreciation is due to my colleagues and students at the University of Alabama, Gadsden, for their tolerance and understanding in the final days of preparation of this manuscript. Sincere thanks are due to one individual of each institution: Dr. Roy V. Scott, Professor of History at Mississippi State University, and Dr. Maxine Rose, Assistant Professor of English at the University of Alabama, Gadsden, for the invaluable assistance that they provided in editing portions of the manuscript.

I must give special thanks to those present and former employees of the District who took hours from their busy schedules to discuss with me the accomplishments of their respective divisions: Mr. V. C. Ahlrich, Assistant Chief, Planning Division; Mr. John W. Anderson, Executive Assistant and Chief, Public Affairs Office; Mr. Jack P. Canizaro, Chief, Real Estate Division; Mr. Clarence Cox, Chief, Communications Center; Mr. R. H. Campbell, Chief, Mat Sinking Unit; Mr. Charles M. Elliott, Chief, River Stabilization Branch; Mr. R. P. Flanagan, Chief, Planning Division; Mr. Fred Ford, Chief (ret.), Electronics Section; Mr. R. T. Harper, Jr., Chief, Flood Plain Management Branch; Mr. Davis S. Haworth III, Chief, Flood Control Section; Mr. John E. Henley, Chief, Engineering Division; Mr. Sam O. Hernandez, Chief, Project Operations Branch; Mr. John E. Hite, Chief, Operations Division; Captain John L. Marlow of the towboat *M/V Mateur*; Mr. Stacy McKnight, Value Engineer Officer; Mr. Kenneth E. McLaughlin, Comptroller; Lieutenant Colonel (ret.) R. W. Sauer, former District Engineer; Mr. St. Clair Thompson, Chief, Environmental Resources Section; Mr. Charles A. Wilkerson, Civil Engineer, River Stabilization Branch; and Mr. Billy J. Woods, Chief, Recreation-Resource Management Branch. Appreciation is also due to Mr. E. F. Livingston, Contracting Officer and Chief, Procurement and Supply Division, and Mrs. Marjorie R. Branan, Chief, Management Analysis Branch, who have served on the District Historical Committee with several of the other individuals named above.

I must also acknowledge the host of others too numerous to name who answered the many questions that plagued this historian as he tried to grasp the technicalities of engineering, the many individuals whose identities I never learned but who worked behind the scenes to gather vital information, and those who expressed such interest in the project but could not be interviewed due to time limitations.

And, finally, I thank my wife and colleague, Elizabeth Shown Mills, who took the time from her own busy schedule to assist me in every way possible. She has certainly been more than a mere typist and research assistant—she has been an honest critic, a responsive sounding board, and a friend in time of need. I will always be grateful that she pushed this manuscript through to completion for me when an automobile accident disabled me and destroyed a portion of the completed manuscript.

Gary B. Mills

CREDITS

Charles Bodmer's hand-colored drawing for Prince Maximilan von Neuwcid's *Travels in North America*, 1843. Reprinted in *Master of the Mississippi*, by Florence L. Dorsey, published by Houghton Mifflin Company, Boston, Mass., p. 1.

Clayton Rand, *Stars in Their Eyes*, Dixie Press, Gulfport, Miss., pp. 2 (top), 3, 13 (left and right).

Mississippi Department of Archives and History, Old Capitol Museum, Jackson, Miss., p. 2 (center).

Minnesota Historical Society, St. Paul, Minn., p. 2 (bottom).

National Geographic Magazine, Washington, D. C., pp. 127, 131, © 1927.

The American Dredging Company, Fort Washington, Pa., p. 76.

The Arkansas Gazette, Little Rock, Ark., p. 189.

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The Old Court House Museum, J. Mack Moore Collection, Vicksburg, Miss., pp. 27, 35-37, 41, 65, 68, 74, 75, 89, 90, 94, 95, 98, 115, 119, 127.

The R. W. Norton Art Gallery, Shreveport, La., p. 20, © 1970.

U. S. National Military Park and Museum, Vicksburg, Miss., p. 32.

Chapter I
CHALLENGE AND RESPONSE

DEVELOPMENT OF THE VALLEY

For a century and a half after the discovery of the Mississippi River, the monarchs of Europe eyed its valley, motivated by a greed for wealth and a lust for power. Spain, France, and, belatedly, England sent their explorers and engineers to assess the potential of the valley and the possible means of exploiting it. As Spain dallied and England pondered, France seized the opportunity to expand her colonial boundaries. Her Canadian *voyageurs* pushed into the upper reaches of the Mississippi throughout the latter half of the seventeenth century, staking France's claims wherever friendly Indians permitted them to roam. Before that century closed, in 1699, a similar expedition planted the seeds of French dominion at the Mississippi's mouth.

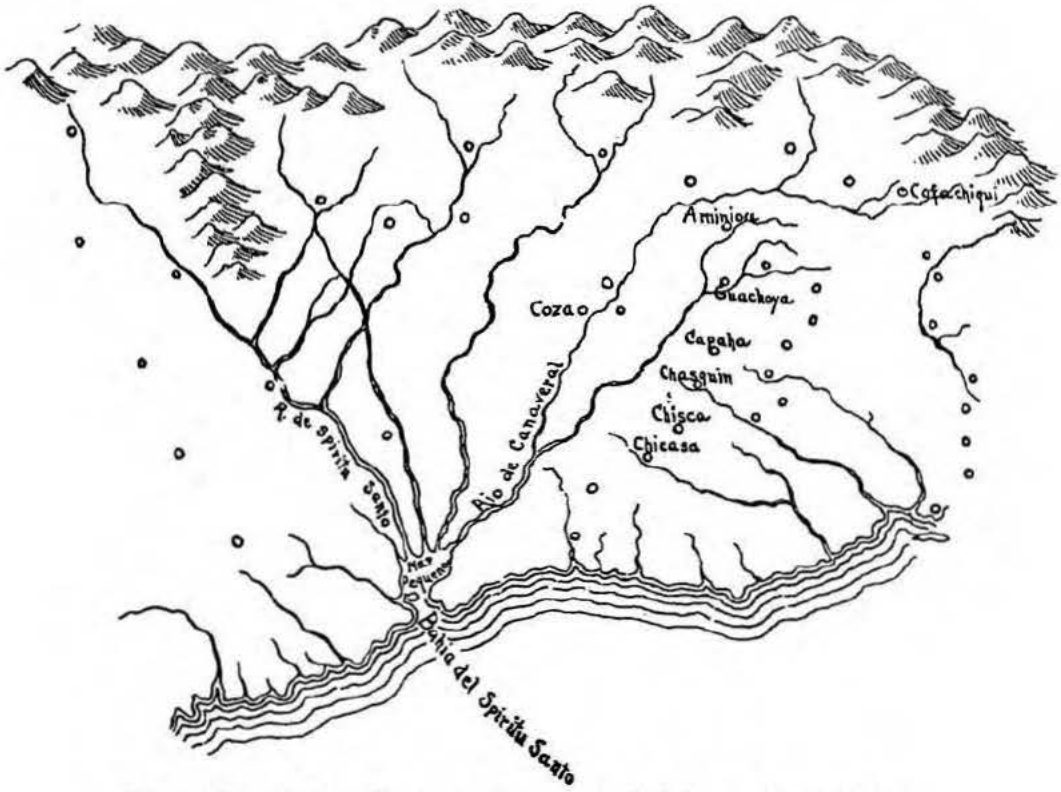
Attempts to strip the river of its inherent dangers and convert it into a tool of civilization began immediately. Within the first months of the Delta's occupation, Jean Baptiste Le Moyne, Sieur de Bienville, took from the river a drift wrack that barred the passage of his boats. Several mines were located along the banks of the upper river, some of which were worked. In 1702 the valley's first shipment of copper was rafted down the Mississippi from the Illinois country to the Gulf.

By 1705 a cargo of 15,000 bear and deer

Encampment of early traders on the Mississippi River

Sieur de Bienville

DeSoto and his crew arrive on the banks of the Mississippi



The valley of the Mississippi as recorded by early explorers

St. Denis

hides had been floated down the treacherous channel of the Mississippi by the French Canadians of the Wabash area; commercial exploitation of the newly opened waterway had begun in earnest. By leaving the river just below the present city of Baton Rouge, Louisiana, these *coureurs de bois** could follow the Bayou Manchac to its outlet, Lake Pontchartrain. From that point, they entered Mississippi Sound and hugged the Gulf Coast until they reached the provincial capital at Mobile, from which point their goods could be shipped to France. In choosing Pontchartrain as their exit to the Gulf, these forerunners of commercialism in the valley anticipated the importance of the lake as the future site of the Gulf Coast's leading port.

More intensive exploration of the lower Mississippi Valley was promptly initiated by the French settlers of the Gulf. The Red, Ouachita, Yazoo, and Tombigbee Rivers were probed, and civilization spread onto their banks. An outpost was established on the Red by St. Denis at the site of the Natchitoches Indian village, just east of the Sabine River, as a deterrent to Spanish advance into the territory.

Within 2 years, by 1716, a second post had been erected near the village of the Natchez Indians. From this strategic site, the colonial soldiers could guard well France's assumed monopoly over the Mississippi River. Again, in 1718, Governor Bienville ordered the construction of yet another settlement, this one at a promising site he had selected on the Mississippi near Lake Pontchartrain. The resulting post of New Orleans was soon to be declared the provincial capital.

The establishment of New Orleans resulted in the first flood-control efforts on the Mississippi. As woods were cleared for the construction of the first city blocks, a small *élevée* was thrown up to protect the area from

Villages at Natchez and Natchitoches

* Black marketeers who traded with the Indians for their own profit.

Antebellum home built on Indian mound to escape high water

inundation. In 1724 the levee and drainage canal principle was extended to the protection of farmland, and the resulting litigation marked the first legal decision handed down on flood control in the Mississippi Valley.

Prior to that year, emerging plantations along the river were subject to the whims of nature. Then, three Canadian brothers named Chauvin, who had developed the most productive concession in the region, sought to protect their labors through the erection of a levee, the closure of a threatening bayou, and the construction of a drainage ditch. The cooperation of their neighbors in extending the levee was requested. One neighbor joined the effort; the others refused.

Spring brought the usual floods. The Chauvin concession of Tchoupitoulas and the neighboring Dubreuil plantation, which had been simultaneously leveed, escaped damage. The adjacent Ste. Reyne concession was extensively flooded. Ste. Reyne's manager filed suit against his neighbors, charging that their alteration of the natural pattern of the area had directly caused his crop losses. The Superior Council agreed.

At the same time, however, the Council supported the practicality of levees, wherever plantations fronted a major waterway. In fact, the Council decreed all property owners along the Mississippi to levee their own waterfront as part of a solid and contiguous levee system. This ruling would serve as the basis of all flood-control legislation throughout the remainder of the colonial era and well into the early American period of the lower valley's history.

The application of this principle extended to the major tributaries of the Mississippi as well. Riverfront concessions throughout French and Spanish Louisiana were made contingent to the implementation of flood-control measures by grant recipients. By 1812, the year that Louisiana was granted statehood, the state boasted 340 miles of levees along the Mississippi alone at an estimated cost of $6 million.

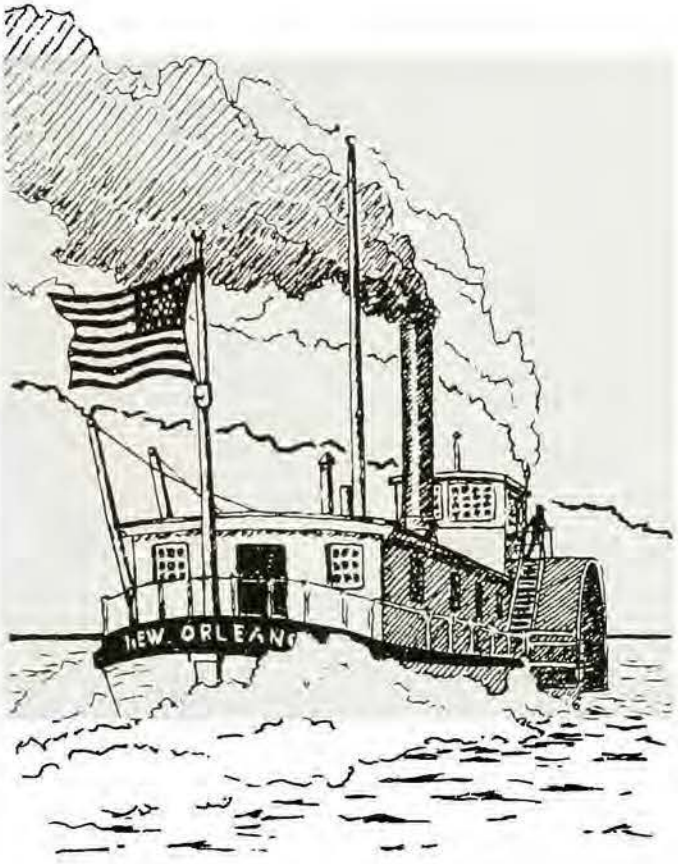
Some degree of commercial growth in the Mississippi Valley prevailed throughout the colonial period, but that degree fell far short of potential. America's successful revolution placed her in control of the east bank of the upper Mississippi, but Spain still controlled the west bank as well as the lower valley. Trade on the Mississippi was then dependent upon the unstable diplomatic relations between the United States and His Catholic Majesty, and the issue of commercial dominance was one which both nations deemed important.

In this political-commercial contest, Spain sought to prohibit the United States from using the Mississippi as a transportation route. It was her design to separate the western colonies of Kentucky and Tennessee from the new confederation of states, since these two

colonies, under an independent government, would make an ideal buffer between the vast, ambitious, new nation and the Spanish holdings to the South and West. The United States countered that the British had once been allowed to claim the Mississippi River as the western boundary of North Carolina. The American government, as the successor to the British colonial government, thereby owned this same territory.

The disputed area along the east bank of the Mississippi extended for some 100 miles, roughly from the modern cities of Vicksburg on the south to Memphis on the north. In October 1795, the boundary controversy was partially settled, and America's access to the Mississippi advanced itself considerably. Under the terms of the new Treaty of San Lorenzo, Spain agreed to withdraw from all east bank territory in the lower valley that lay above the 31st parallel. The United States was also accorded navigation rights to the lower Mississippi and allowed usage of the New Orleans port.

The survey of the disputed boundary line began the following fall. The United States agent was Andrew Ellicott, a "surveyor, astronomer, mathematician, and, on occasion, soldier and diplomat" who specialized in "the solution of vexatious boundary problems for the Federal and state governments." Ellicott was also an expansionist and, before the completion of his survey, had generated sufficient anti-Spanish sentiment to accomplish the American takeover of the Spanish fort at Natchez.



The New Orleans, *first steamboat to travel the Mississippi*

Spanish control of the western bank of the Mississippi also was doomed. In 1800 France's imperialistic leader, Napoleon, persuaded an apprehensive Spain to forfeit the Louisiana colony she had acquired three decades before, and in 1803 Napoleon sold the entire expanse to the United States. The emperor's motive was selfish: by building the American economy, he foresaw an opportunity to weaken his greatest rival—Great Britain. But in doing so, Napoleon also gave tribute to the boundless potential of the Mississippi Valley and expressed his belief that this potential could best be developed by the United States.

The purchase of the Louisiana Territory ushered in a new era of America's growth. The exploration of her new lands was a primary concern of the United States government. Agents were sent upon all the major tributaries. Ambitious Americans swarmed into the newly opened lands along the river. Settlers of the upper Mississippi and Ohio River Valleys made increasing use of the

Mississippi for transportation as well as commercial purposes. A trade avenue that had carried a million dollars worth of produce in 1798 was handling a $5-million-per-year operation in 1807. The introduction of the steamboat to the Mississippi River exploded even this figure.

With the expansion of agriculture and commerce in the lower Mississippi Valley, new public concern was generated. Planters coveted the Delta lands, but their desires were thwarted by the very floods that gave those lands their unsurpassed fertility. Steamboat interests demanded improved waterways upon which to transport the Nation's products. Snags, sandbars, and shoals posed severe threats to rivercraft, especially in the turbulent and unpredictable channel of the Mississippi.

Anticipating these national problems and the financial battles that would ensue, Thomas Jefferson pondered the value of improving America's rapidly expanding territory:

> *Shall it (tax revenues) lie unproductive in the public vaults? Shall the revenue be reduced? Or shall it not rather be appropriated to the improvement of roads, canals, rivers, education, and other great foundations of prosperity and union....*

Congressional acknowledgement of national responsibility was slower in coming. In 1820 a legislative appropriation first provided $5000 for a survey of the Mississippi and Ohio Rivers to determine the most practical way of improving navigation on these two waterways. Federal acknowledgement of responsibility for flood control, however, in the lower Mississippi Valley still lay far in the future.

Throughout most of the first half of the nineteenth century, the incessant fight of Delta residents against annual floodwater was a personal battle, a losing battle for most of them. Plantation owners who dared to encroach upon the floodplains were laborious as well as bold, but they were not engineers.

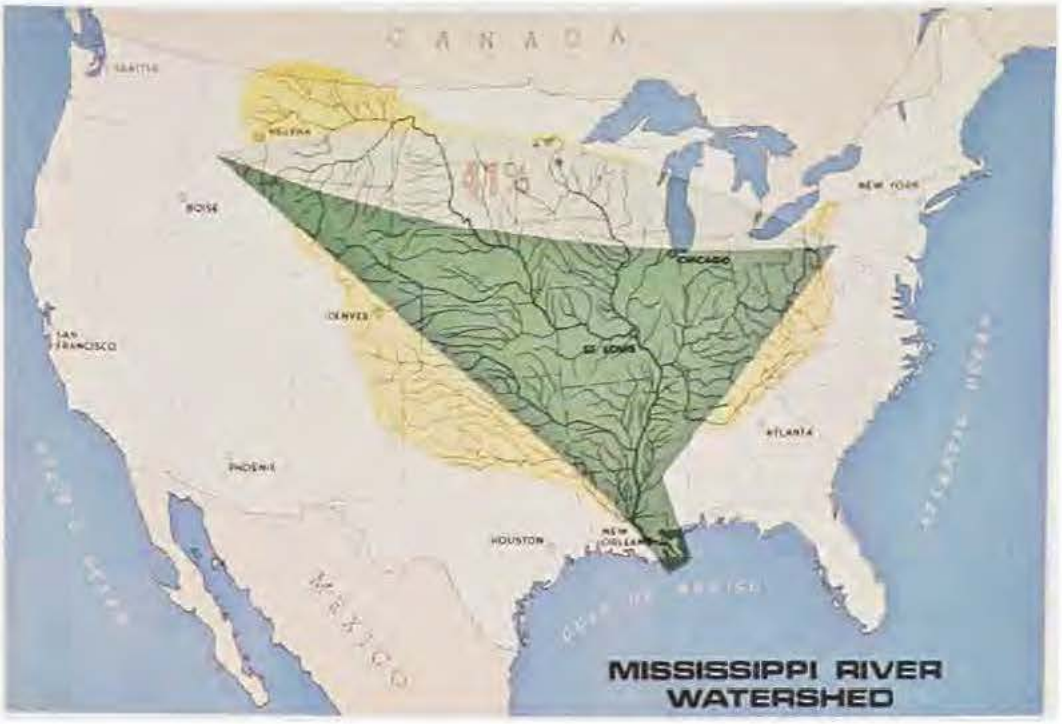
Like in the days when cotton was king, the front yard of this beautiful antebellum home has been turned into cultivated cropland. This home near Glen Allen, Mississippi, was built in the 1830's on the banks of the Mississippi River and was probably vulnerable to flooding

Too few of them were acquainted with the principles of effective flood control or the correct application of these principles.

The earliest levees that were built in the lower valley were little more than "potato ridges" in comparison with the mammoth earthen walls that would eventually be raised. A levee built *en amateur* was usually a simple line of dirt made by digging two parallel trenches and piling the spoils in the middle. Limbs, logs, and stumps often were left in the mounds. As the dirt settled, it shrank away from the wooden debris and left cavities that weakened the entire structure. The deep trenches in front of and behind the levees soon filled with water and made repair work on the levees much more difficult in times of emergency.

Moreover, each man's approach to the problem considered his own needs foremost. Adjacent owners frequently worked at odds with each other, and none succeeded. In several of the valley states, county or state governments attempted to exercise authority over flood-control procedures. Uniform codes for levee construction were adopted, participation of the citizens was made mandatory, and taxes were levied for public works. The use of levees as roads, a common custom, was prohibited. Fines were levied for erecting fences across the levees or for permitting hogs to roam and root the dirt embankments. Moreover, competition between states became an unending treadmill as the occupants of one bank of the river sought to protect their holdings by building their levees higher than those of the state on the opposite bank.

Resentment mushroomed among various segments of the Nation's population. As the backcountry of the new states began to fill with settlers, riparian owners became rankled over the fact that their levees protected the new settlers who contributed nothing toward the maintenance of these levees. The extreme southern states bitterly resented the fact that



they were annually deluged with the drainage which washed downriver from the northern states who likewise contributed nothing toward the maintenance of the protective levees. The solution for a nationwide problem was obviously being foisted upon those who suffered the most from it, and the treatment of a national issue was being pursued on a sectional basis. A central authority responsible for exercising control over the whole drainage basin of the Mississippi was vitally needed—but the central government was reluctant to accept that responsibility.

The worsening problem reached crisis proportions in 1844 when the Mississippi lost all patience with man's persistent intrusion upon its domain and treated its unbidden guests to a disastrous overflow. The Mississippi Delta was ravaged. Ninety-five percent of her plantations failed to produce a single pound of cotton. At a public meeting in October 1844, planters of the Greenville area of Mississippi adopted a resolution to the effect that any demand for payment of debts made upon any flooded farmer within a year was "a clear case for pistols and coffee."

On the eve of the flood, President John Tyler had addressed Congress in a manner most encouraging to valley residents:

> *The Mississippi occupies a footing altogether different from the rivers and water courses of the different States.... It belongs to no particular State or States, but of common right, by express reservation, to all States. It is reserved as a great common highway for the commerce of the whole country. To have conceded to Louisiana, or to any other State admitted as a new State to the Union, the exclusive jurisdiction, and consequently the right to make improvements and to levy tolls on the segments of the river embraced within its territorial limits, would have been to have disappointed the chief object in the purchase of Louisiana, which was to secure the free use of the Mississippi to all the people of the United States.... The United States, therefore, is charged with its improvement for the benefit of all, and the appropriation of governmental means to its improvement becomes indispensably necessary for the good of all.*

Yet, the growing hopes for Federal assistance in the wake of the disaster of 1844

were dashed early the following year with the accession of James K. Polk to the presidency. An era of internal improvements that pushed roads through the wildernesses and cleared waterways for increased navigation came to a halt. Contending that Federal waterways improvement appropriations were unconstitutional, Polk vetoed every such bill that appeared before him—up to the very eve of his departure from office. The question of Federal flood control, in his view, was not supportable.

In opposition to the increasingly stringent Federal policy, a series of widely publicized conventions were held throughout the Mississippi Valley. At Memphis in 1845, the aging statesman John C. Calhoun presided over an assembly that starkly dramatized the problems of the Mississippi Valley. On his way to the convention, Calhoun toured the South from Charleston, South Carolina, to New Orleans and took a packet up the Mississippi. He sought and received extensive publicity for his purpose, and he earned the widespread acclamation of the Delta residents who lined his route. Particularly notable was the celebration at Vicksburg, where the young Jefferson Davis presided over a lavish banquet.

Upon taking the chairman's seat at the Memphis assembly, Calhoun delivered an emphatic address in which he denounced, on general principle, most Federal involvement in internal improvements. "Log-rolling" was too often the result. However, the Mississippi question was a different matter. Calhoun sincerely felt that where this "great highway of western commerce" was concerned, the "government was as much obligated to protect, defend, and improve it in every particular, as it was to conduct these operations on the Atlantic seaboard" where the usual justification was the issue of national protection.

Out of the Memphis convention evolved yet another recommendation that would later have great impact upon the settlement of the Delta. There were "millions of acres of public domain" lying on the Mississippi River and its tributaries. Their fertility was unsurpassed, yet they were presently worthless for cultivation. It was recommended that Congress make these swamplands available to interested settlers on a grant basis to encourage the area's development.

Throughout the Polk administration the demand continued for national assistance to the Delta. In 1846 the legislature of Mississippi asked the Federal government to grant the state a large tract of swampland in Wilkinson and Adams counties upon which it could build levees. Numerous additional memorials were sent by the Mississippi legislature, seeking congressional intervention in the flood-control fight. In 1847 a second waterway conference was held to discuss the problem of the Mississippi as a whole, this time at Chicago, and was followed by yet another conference at Cincinnati.

By 1848 the mass sentiments of the valley's residents, and of her commercial and navigation interests, could no longer be ignored. The issue arose in Congress and generated considerable support. Abraham Lincoln acknowledged before the House that improvement of lands in the Mississippi River Valley would benefit certain individuals, yet—he felt—the growth of the Nation as a whole depended upon the adequate development of that region. Late in that same year, the valley's

"King Cotton", the fiber from which the early Southern culture was molded

cause won even more powerful support with the election of Zachary Taylor to the presidency. Taylor was not only a general renowned for his success in the Seminole and Mexican Wars, but he was also a planter from the Louisiana Delta.

A crisis of national import occurred again in 1849. The lower valley, which had not yet recovered from the flood of 1844, again was devastated. Agricultural and commercial interests themselves flooded Congress with petitions for Federal aid, and it was at last acknowledged by a Congressional majority that the fertile lands of Mississippi and Louisiana "should be protected from the ravages of northern waters."

Two acts were passed in 1850 that laid a foundation for the long-sought Federal assistance. Late in March, it was acknowledged that the Mississippi Valley deserved, at least to some extent, the type of protection that was being given to the Atlantic seacoast. The alluvial Delta contained some 25,000 square miles that were seriously in need of leveeing, an area comparable to the total expanse of the States of Delaware, Maryland, Connecticut, Rhode Island, and Massachusetts. Its immensity could be ignored no longer. With its Act of 28 March 1850, Congress capitulated, at least partially. A survey of the area was authorized, and some degree of Federal cooperation with levee builders was promised.

In the autumn of that same year, yet another beneficial piece of legislation was passed—the Swamp and Overflow Land Act of 28 September 1850. Twenty-eight million acres along the Mississippi River were given to riparian states. Louisiana alone received 8,500,000 acres of these lowlands, another 3,290,285 was ceded to the State of Mississippi, and 7,770,958 acres to Arkansas. All of these states opened offices for the sale of the swamplands and, in keeping with the terms of the Federal act, the proceeds of the sales were used to finance the vitally needed public works—levees and drainage systems.

The economy of the lower Delta swelled and reached braggart proportions in the decade that followed. Settlers swarmed into the lands that lay behind the new or promised levees. Protected fields produced abundant

crops of cotton, and the planters along the river invested their increased funds in new protective works. Yet 1850 brought a decade of false dreams. In 1857 and 1858, United States engineers reported that the levees protecting the Yazoo bottoms of Mississippi averaged only 4 feet in height. Many were hastily, and poorly constructed; most of them would not withstand a major flood—the prediction proved true. In the spring of 1859, the levees broke and the Deltans were impoverished.

For a century and a half, civilized man had attempted to thwart the annual rages of the Mississippi. Individual effort had failed. Cooperative effort on a state, district, and county basis had been attempted; this too was ineffective. By 1860, it had become increasingly obvious that a successful war over such an immense battleground could be waged only by a consolidated army under one authority. The question of flood control in the Mississippi Valley, like the issue of navigation improvement on its waters, needed to be handled by the central government and directed by men of superior training and experience.

AN ARMY OF ENGINEERS

A force of such capability did exist—within the army of the United States. From the very birth of the Nation, its leaders had recognized the necessity of maintaining a body of men trained in engineering principles. On 16 June 1775, one day before the Battle of Bunker Hill, the Continental Congress of the United States authorized the formation of a new but small corps to consist of a Chief Engineer for the Grand Army and two assistants.

By December of that year, Congress acknowledged the urgent need to expand that force, yet there were few qualified men in the colony to fill it. With frank sarcasm, General Charles Lee had declared that not one officer existed "who knew the difference between a *chevaux-de-frise* and a cabbage garden." To fill this void, the insurrectionary government prevailed upon its strongest ally, France. Within the French army were the most skilled engineers of the modern world. Despite American military resentment of the idea and the reluctance of colonial officers to serve under men of another nation, General Washington and the Continental Congress imported, in 1777, a body of officers from the royal corps of engineers of the French army. One of their number, Louis le Bégue du Portail, was elevated to the rank of Brigadier General and given the duties of Chief Engineer.

Foreign officers dominated the Engineers throughout the war, and for many years subsequent the Corps remained under their

Louis le Bégue du Portail

influence. In the decade between 1783 and 1793, the Corps was disbanded temporarily. No national emergency arose that required its services, and the fledgling government was too involved with the difficulties of its own establishment to become engaged in internal engineering improvements in the varied states. In March of 1794 however, worries over another possible conflict with England prompted Congress to authorize the fortification of America's coastal harbors, and the Corps of Artillerists and Engineers was brought into being—again under the dominance of French-born officers.

In the early days of the Corps, a distinction was made within the Corps between engineers who devised and constructed military works and those who performed exploration and topographical mapping services. With the reorganization of the Corps in 1802, emphasis was placed upon the military role of the engineer. In 1813 an auxiliary Topographical Bureau was established which later evolved into a separate Corps of Topographical Engineers. Not until 1863, in the face of wartime emergencies, did these two engineering functions combine once again into a single, comprehensive Corps of Engineers.

With the addition of the Louisiana Territory to the United States, the increased surge of Americans westward, and the development of steamboats which revolutionized river navigation, there arose an even greater demand for military and civilian engineers. There was new territory to be explored and mapped, and settlers urgently needed access roads, as well as protection from hostile Indians, in the rugged areas they were invading. Increased usage of water routes for commercial and personal transportation demanded these waterways be kept in navigable condition.

The Engineer Department of the United States Army provided the technical knowledge to support these surges in America's development. The Engineers possessed the best technical training in the Nation. Their impartial distribution of services and uncorrupted leadership offered stark contrast to the Machiavellian business practices of that era and generated much public confidence.

Moreover, the experience offered by such civil works provided an excellent means by which the Army Engineers could maintain and improve the skills they needed to defend the country in times of war.

And so, at the ports of Vicksburg and Cairo, along the White River of Arkansas, the fabled Red of Louisiana, and the spidery Yazoo River of Mississippi, the Engineers of the United States Army offered their labor—and often their lives—to the improvement of the quality of American life.

VALLEY EXPLORATION AND THE ENGINEERS

Long before the United States Army Engineers created their Vicksburg District, its men were sent into all of its hinterlands. Military engineers explored, surveyed, laid roads, improved its waterways, and provided protection to the frontier settlers. The work was sporadic and often minute, but its importance to the entire Nation, as well as the immediate area, cannot be overestimated.

Much of the region that was to become the Vicksburg District had been explored and settled prior to its acquisition by the United

W.C.C. Claiborne

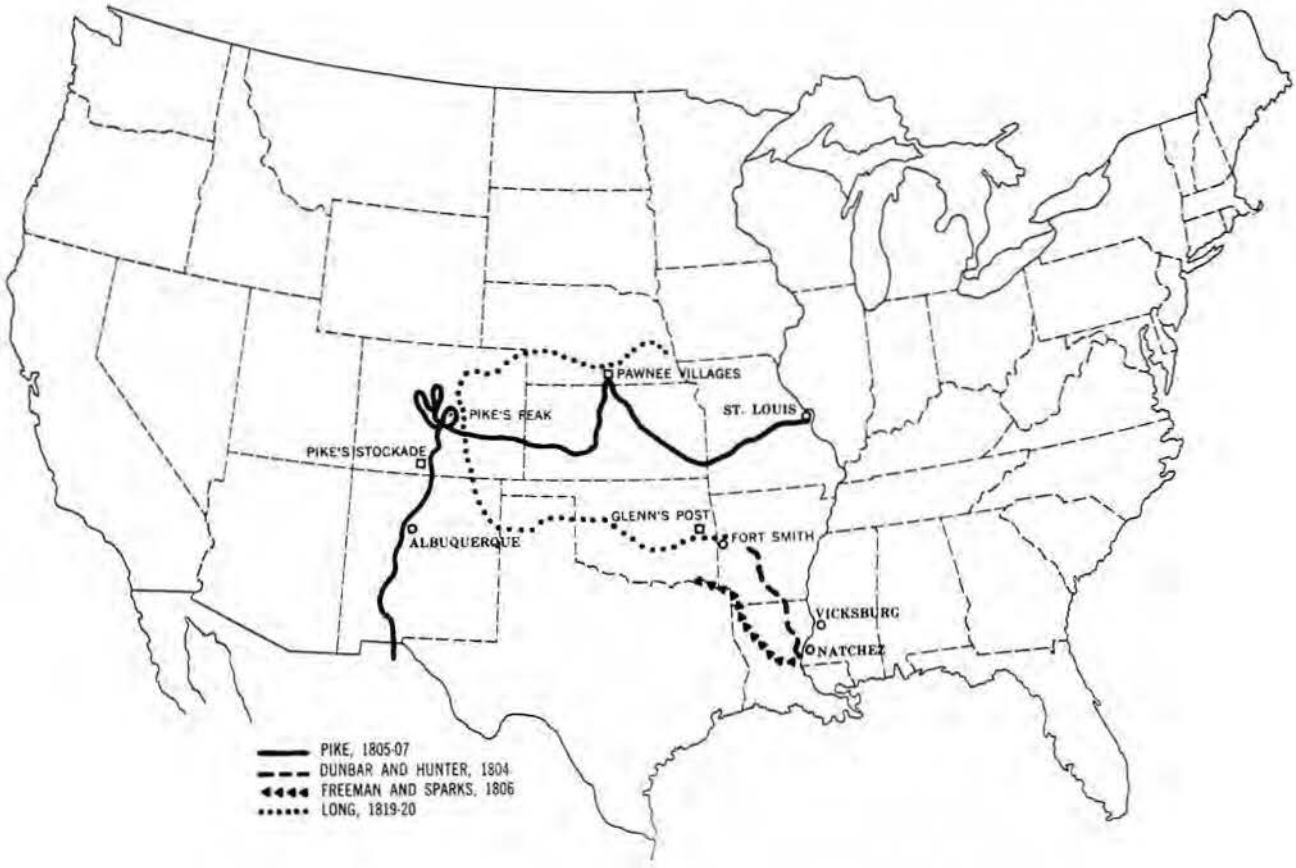
William Dunbar

Daniel Clark

States, but a vast proportion of it had not. Even lands that the French and Spanish had occupied and traversed were alien to Americans. In quest of detailed information upon which he could plan the future of the new territory, President Jefferson queried knowledgeable officials and residents and commissioned agents to scout the farthest reaches of the Louisiana Purchase. Exploration began anew throughout that vast region from modern Mississippi to New Mexico that would one day become the Vicksburg District.

To a great extent, the earliest agents relied heavily on details furnished by those who already inhabited the area. John Sibley, a New England physician and Indian agent stationed at Natchitoches; William Dunbar, a Natchez scientist; Daniel Clark, the United States Consul at New Orleans; and W. C. C. Claiborne, the territorial governor of Louisiana, forwarded initial reports to Jefferson that focused upon the more settled and more explored eastern portions of the territory. Although the more western parts were not extensively studied, the unexplored areas on which more information was needed were defined.

In 1804 Dunbar and a Philadelphia chemist named Dr. George Hunter were commissioned to make the first expedition into the unsettled regions. With a party of sixteen that included Hunter's son (a United States Army sergeant), twelve enlisted men, and Dunbar's black servant, the two agents left St. Catherine's landing at Natchez in October. Their party ascended the Red as far as its juncture with the Ouachita, proceeded past the old Spanish outpost of Fort Miro, and charted the Ouachita as far as the site of the modern city of Hot Springs.



Although the Red River was by far the most significant tributary of the lower Mississippi, it had never been explored to its source by the Europeans who settled its lower banks. Its full extent was unknown. Colonial officials of France and Spain had ignored it. The most extensive colonial exploration was undertaken in the late 1750's by a French-Indian settler at Natchitoches, Jean Baptiste Brevel, Jr., who had spent many months upon the upper Red with a hunting party of Indian friends. Brevel's description of this river, which Dr. Sibley forwarded to Washington in 1805, recounted a host of branching streams, mountainous terrain, rock salt, and silver ore—and aroused the interest of the new government.

The early neglect of the Red River was largely due to a navigational obstruction which had existed from the earliest recollections of the native Indian tribes. North of the colonial outpost of Natchitoches, for more than a 100 miles, there stretched a vast series of natural rafts. Logs and debris clogged the channel; trees grew in their midst. Miles of this stretch of river could be traversed by horseback. For all practical purposes, Natchitoches long had been the head of Red River navigation.

Spurred by Sibley's recital of Brevel's Red River findings, the American government, in 1806, funded an exploration of that river and charged its organization to Dr. Dunbar. To command the expedition, Dunbar chose Captain Richard Sparks of the U. S. Army. His supporting force, which left Fort Adams April 19, consisted of a surveyor, Thomas Freeman, who had just completed a boundary line between what is now Florida and Mississippi; a botanist, Dr. Peter Custis; nineteen enlisted soldiers under Lieutenant Enoch Humphreys; and a negro servant. The object of the expedition was to map the Red River and record findings in the newly acquired area.

Five days out of Natchitoches, the small force met rumors of impending Spanish resistance from Nacogdoches to their

encroachment upon the upper Red. A supplemental detachment of twenty men and one officer was borrowed from the local garrison, and the expedition continued. By route of bayous, lakes, pools, swamps, and marshes, the force pushed their way through northwest Louisiana toward the present Oklahoma-Texas boundary, frequently clearing small rafts and hacking obstructions from the detour that they were forced to take around the primordial Great Raft. On the 16th of June, a Coashatta Indian village was encountered on their backwoods route. The American flag was presented to the chief in gift, and—in compliance with President Jefferson's instructions—the Indians were encouraged to remain friendly to the new government that dominated their territory. After 14 days of rough travel, the party reentered the Red River above the raft.

Six weeks of additional exploration brought the Dunbar-Freeman expedition to a point 635 miles upstream, the deepest penetration the United States yet had made into the Texas plains. On July 26, the party finally encountered the Spanish troops sent to turn them back. In the face of overwhelming military odds, the weary American forces, after a brief conference with the Spaniards, withdrew without taking issue. The source of the Red was still unknown, but the Dunbar-Freeman expedition had made a significant contribution to the scientific and geographic knowledge of the American Southwest.

Zebulon Pike

Stephen H. Long

American efforts at Red River exploration were to involve several other expeditions in the early nineteenth century. None succeeded in locating its source. Some, such as young Lieutenant Zebulon Pike's trek of 1806-1807, which the Spanish also intercepted, were rumored to be covers for more ambitious designs upon Spanish territory. In 1819 the Topographical Bureau of the Corps of Engineers entered the field of Western exploration with the implementation of a grandiose expedition that would establish America's foothold in the Southwest. But, the plan faltered as Congress lost enthusiasm. In the end, the entire plan was capsulized into a small scientific expedition upon the Arkansas, Platte, and Red Rivers.

Led by Major Stephen H. Long, this expedition of the Topographical Bureau also failed to discover the headwaters of the Red or the Arkansas. Led by clues from members of the Kaskias tribes, he thought he had found the Red River; however, it was actually the Canadian and Arkansas Rivers. Yet the findings of these explorers revolutionized the prevailing opinions of cartographers who mapped the river system in the southwest reaches of that expanse which one day would become the Vicksburg District.

The first valid hint of the true source of the Red River came from a Dr. Janes who accompanied Long. Janes said that persons arriving at St. Louis from Santa Fe, among them the brother of the legendary Henry M. Shreve, gave strong indications of the vicinity of the Red's headwaters. Not until 1852 would the elusive source of the Red River be discovered by Captains Randolph B. Marcy and George B. McClellan of the Engineer Corps.

In the decade between 1840 and 1850, the Topographical Bureau of the Corps of Engineers was again at work in the Red River Valley, resolving the international boundary disputes that hampered the settlement of the southwest plains. In 1840 the Sabine River boundary line between Spanish Texas and American Louisiana was run by a force of Engineers under the command of the Topographical Bureau's Major James Duncan Graham.

Martin L. Smith

Joseph B. Totten

However, the boundary was not long respected. Agressive Amerians continued their contest for possession of Texas, and by 1848 the boundary between Mexico and the United States had been pushed backward to the Rio Grande. In the summer and fall of 1850, U. S. Army Engineers were sent again to Texas to run the new boundary and select the best fort site from which the United States could maintain possession of the territory. Prominent in this survey expedition was the young Lieutenant Martin Luther Smith, later the chief Confederate engineer at Vicksburg.

INTERNAL IMPROVEMENTS BEGIN

The surge of national growth which occurred in the first half of the nineteenth century demanded not only the exploration of water routes but their improvement as well. In 1820 Congress faced its responsibility for fostering the development of the Mississippi Valley and authorized a survey of that river with a view toward improving it. Command of the survey was given to General Simon Bernard, a former engineer in the armies of Napoleon and a special consultant to the United States Army Corps of Engineers, and to Colonel Joseph B. Totten, later Chief of the Engineers.

Under the direction of these two engineers, the most thorough examination to date of the Mississippi and Ohio Rivers was made. Multitudinous shoals, snags, and sandbars were recorded, and their immediate removal was recommended. Bernard and Totten's report urged improved training of steamboat pilots, the abandonment of rafts, flatboats, and keelboats, and the diking of banks to prevent crosscurrents and flooding. Implementation of these four recommendations would reduce, drastically, the incidence of fatalities on America's major waterway.

Although Bernard and Totten's survey focused primarily upon methods for the improvement of navigation, it also involved the question of flood control. The levees which had been built by riparian owners not only reduced the danger of flood but also reduced the lateral currents that especially endangered navigation on the Mississippi. The recommendation of increased dikes, or levees, that was made by these two highly respected engineers established a very important precedent for future flood-control efforts.

The Bernard and Totten survey aided Southern and Western congressmen in making a successful push for river and harbor appropriations for their constituencies. In 1824 their colleagues capitulated to their demands and voted $75,000 for the improvement of these two rivers under the direction of the Corps of Engineers. With the passage of this act, signed by President James Monroe, the congressional and executive branches of the government committed themselves to the policy of internal waterways improvement, but it was a commitment that they would frequently forget or ignore during the decades that followed.

Although trees were cut below the water level in the high-water season, the stumps protruded dangerously when the water level dropped, providing ideal conditions for the formation of a raft

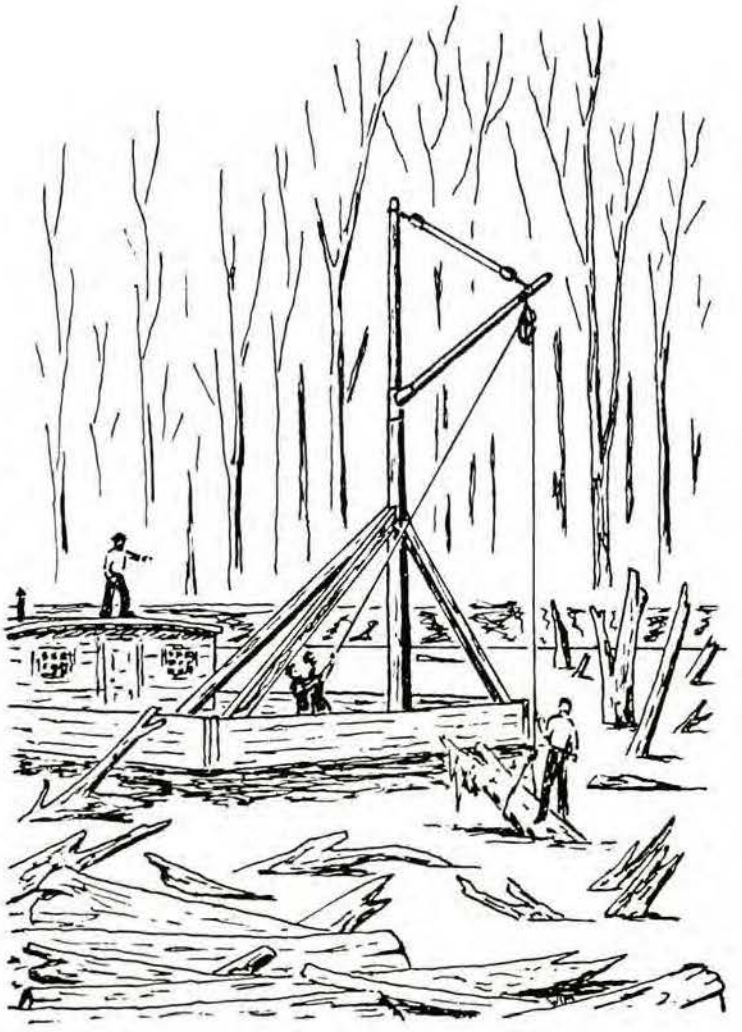
In 1824 there were no less than fifty thousand snags in the Mississippi River. These *chicots*,* as they were called by the colonial French, were fallen trees which had embedded themselves upright in the river floor. Their jagged trunks and branches stretched upward for as much as 100 feet, as they lay in wait for unsuspecting vessels they could spear and sink.

Two methods existed for dealing with these snags. They could be sawed off during low-water seasons, or they could be removed completely. Both methods presented serious problems. Sawed-off snags left stumps; since these could not be seen in higher water, they still remained dangerous obstructions at certain water levels. On the other hand, removal of the larger, more embedded snags was not possible with existing machinery.

The Rivers and Harbors Act of 1824 had authorized the acquisition of "watercraft, machinery, implements, and force." Using this act as his authority, the Chief of Engineers offered $1000 of the appropriation as a prize for the best-designed snag-removing machinery. Contending models submitted for the purse ranged from the ingenious to the promising to the weird. Ultimately, the award was made to an ambitious Kentuckian, John Bruce, who personally took his plans to Washington along with a proposed contract for removing the snags himself.

Bruce's design was modestly termed a "machine boat." Essentially it was two flatboats, 8 to 12 feet apart, joined by strong beams which also supported a large hand-powered boom for lifting snags. The device proved effective under the less demanding conditions encountered in the Ohio, but its overall progress was laborious and snail-paced—primarily because it had to be propelled by hand. When the term of his $65,000 contract expired, Bruce had removed only a fraction of the driftwood from the Ohio and none of the impediments in the

* "Teeth of the river."



Mississippi. The project stalled, and Bruce was charged with "defective works and failure to fulfill his contract."

Spokesmen for the commercial, agricultural, and navigational interests in the Valley bombarded Congress for completion of the work that had been authorized. It was imperative that a successor to Bruce be appointed. Yet, few men were qualified or willing to assume the task. Upon the recommendation of Vice-President John C. Calhoun, the War Department appealed to one of the leading steamboat figures of the era, Captain Henry Miller Shreve. Although he was to submit several valuable suggestions in the original contest, all were ignored so he did not compete. This time, however, Shreve accepted the challenge.

Two years before, this noted "Father of Western Steamboating" had designed a snag removal craft that combined steam power with the basic "machine boat" design. The double-hull principle utilized by Bruce also appeared on Shreve's model, but the steam-propelled snagboat was designed to be considerably larger and heavier and it featured a strong "snag beam" connected to the two hulls at the bow. Because of the boat's steam propulsion, a snag could be rammed and broken off or loosened. If the water level placed the snag at the right height, the obstruction could then be lifted with the vessel's steam-powered crane.

Shreve accepted the proffered appointment on one condition: funds must be made available to build the snagboat he had designed for use in the Western waters. His acceptance generated an official appointment, but he was refused the funds to build the equipment he felt was necessary. Subsequent protests were ineffective. Shreve was forced to begin his work with a makeshift combination of flatboat, windlass, chain, and level. This equipment sufficed for the remaining Ohio River work, but Shreve remained convinced that the "twelve-hundred miles of half-submerged forests in the Mississippi" could never be cleared without steam power.

Continued appeals failed. In frustration, Shreve used his own funds to build a small-scale vessel which passed all the tests he put to it. Citing this success, he barraged Washington—by letter and in person—until Congress agreed to a compromise. The United States would underwrite the construction of his snagboat, but any failure of his device would relieve the government of its obligation, and Shreve himself would have to meet all construction costs.

Shreve clearing the Red River Raft

The *Heliopolis*, Shreve's first full-scale snagboat, was completed in April 1829. Its confident inventor put it to work on the most timber-clogged stretch of the Mississippi, Plum Point on the Tennessee shore. Before a raucous, jeering, and cynical crowd, the *Heliopolis* dismembered the entire "forest" of imbedded trees in 11 incredible hours. By summer 1830 the treacherous Mississippi was virtually cleared of the old hazard. With considerable self-satisfaction, Shreve reported to Brigadier General Charles Gratiot, Chief of Engineers, that no Mississippi River vessel had been lost to snags or driftwood during the previous year.

The basic improvement of the Mississippi was not yet done. Trees protruding from the banks of bends had to be removed so that the next flood would not wash them into the river. Numerous wrecks needed to be raised from the Mississippi's floor. Sandbars had to be cleaned of timber and scoured. With dogged determination, Shreve pursued each obstacle that threatened navigation on the Mississippi River and its tributaries, human as well as material.

Inept boatowners and captains frequently felt the brunt of criticism issued by this conscientious Superintendent of Western Waters. Lax officials were another favorite target. When the government failed to act on his suggestion that strict navigation rules be drawn up and enforced to prevent nighttime collisions, Shreve compiled his own list of rules and urged its adoption upon Congress. Each boiler explosion that occurred on a Western river steamboat tormented him anew—and ultimately prompted him to invent a hydraulic pump that would test steam boilers for safety and capability.

The greatest challenge of Shreve's career still lay ahead of him, the Great Raft of the Red River. This relic of prehistoric America grew larger each year as new freshets from the headwaters of the Red undercut wooded banks and swept more debris into the mass. Since the advent of Europeans on the banks of the Red, the raft's rate of growth had consistently swelled until it was enlarging itself at a rate of 1/2 to 1 mile per year. Barred from its normal outlet, its bed rising with accumulated deposits of silt and sand, the river spilled over onto surrounding land and formed new bayous and swamps. The settlement of northwest Louisiana had lagged as a direct result.

Raft north of Shreveport, 1873

By the mid-1820's, many optimistic individuals called for the removal of the raft, but the general public did not believe it possible. As the pros and cons of the issue were bandied, the Federal government sought to alleviate at least part of the problem by contriving a channel which bypassed the seemingly impregnable raft. Short canals were opened and bayous were deepened; but the results were disappointing.

Then a new situation developed that made the opening of the upper Red even more imperative. Mississippi's Choctaw Indian population yielded to American encroachment and agreed to exchange most of its lands for territory in the region that later became Oklahoma. A water route to the area was vitally needed, and the Red River offered that access, provided that it could be cleared.

In 1832 General Gratiot tantalized the indomitable Shreve with a bold suggestion: dismantle the raft one piece at a time for its entire length of 140 miles. Shreve accepted the challenge. Year after year, from 1833 to 1838, Shreve led an expedition into that isolated and sparsely populated region surrounding the raft. Snagging parties as large as 300 men plowed their way upriver from the foot of the raft, dissecting each log and snag and floating or towing off the pieces.

Again and again the work of removal was stymied at stagnant stretches of the Red where currents were too listless to float away the debris. The crew then fanned out to the endless bayous and lakes, closing their outlets on the river and confining the main body of water to the channel of the Red itself until that river quickened and whirled away the debris.

Each working season was short, curtailed by heat and diseases which were a greater occupational hazard than the crews' mammoth saws. But by the spring of 1838, Shreve and his laborers had cleared the whole expanse of river between Natchitoches and the new town of Shreveport in the extreme northwest corner of Louisiana. The navigable length of the river had almost been doubled; Shreveport had replaced Natchitoches as the navigable head of the river and the gateway to the great Southwest.

As the crew progressed upriver, they had blazed their way through wilderness. In their wake, there sprouted an interminable chain of plantations. By Shreve's estimate, the value of

Red River, Shreveport to Natchitoches

the public domain along the banks of the cleared river had increased $15 million. The cost of the project had been $300,000. Still, to a Nation in the grip of an economic depression, this sum was stupendous. Shreve warned that the nature of the river demanded annual appropriations for maintenance or the accomplishments of the past 6 years would be negated. Little heed was paid to his warnings.

Four months after the raft work ended, a summer flood crumbled the banks of the Red and a new mass of tangled debris, more than a mile in length, choked the river at a point 3 miles below Shreveport. Newly emerging plantations were deluged with floodwater. Shreve begged permission to return to the Red and remove the obstacles. After months of delay during which the situation rapidly worsened, his orders arrived—with seriously inadequate funding.

The inhabitants of the upper Red were stunned. The creeping swamp threatened to devour their plantations, most of them already only a few cents away from financial disaster. Shreve yielded to their entreaties at the risk of losing his own post as Superintendent. On his advice, the already heavily laden planters borrowed $7150 more to finance the removal of the new jam, and Shreve promised to do all he could to persuade Congress to reimburse them. His efforts were unsuccessful, and in 1841 he was dismissed from his post.

River and harbor improvement stagnated throughout the lower Mississippi Valley as conservative presidents vetoed every bill presented them in an effort to balance the Nation's wavering economy. Only one nominal attempt was made during this period to clear new accumulations of timber from the Red with a combination of snagboats and the newly discovered explosive, nitroglycerine. Aside from this isolated incident, the congressional and executive branches of government denied every proposal for Red River improvement until after the years of Civil War and Reconstruction.

The Federal retreat from Red River affairs coincided with its retreat from public improvement works in general. In the 1820's and 1830's, the Corps had been exceedingly active in that region later encompassed by the Vicksburg District. The comprehensive survey of Army Engineers in 1826 was vital to the plans for a national road running from Washington, D.C., to New Orleans, Louisiana, a road of great military and economic import. Yet, because of political conflicts among the backers of four competive routes, the plans for the road were shelved.

In the 1830's, Topographical Engineers on loan to private enterprise surveyed a proposed

railroad/canal route between the Yazoo and Pearl Rivers of Mississippi and provided invaluable reports, plans, and estimates for the West Feliciana Railroad to run from Woodville, Mississippi, to St. Francisville, Louisiana. Their services were in constant demand; assistance in some worthy projects, such as a railroad from New Orleans to Nashville, had to be denied because of a shortage of engineers. Yet in 1838 Congress repealed the General Survey Act which permitted the involvement of Army Engineers in the public improvement works of private enterprise.

Route of the West Feliciana Railroad, the country's first interstate rail system

Liquid TNT brought good results and an excellent safety record

Napoleon, Arkansas

From the mid-1830's to 1850, Corps activity in the lower Mississippi plodded to a virtual standstill. Legislation of 1837 authorized construction of Federal marine hospitals for rivermen, under the direction of the Army Engineers, but as Federal interest in the project waned, the work lagged. Six Mississippi River towns had been selected as hospital sites; three of them fell within the eventual boundaries of the Vicksburg District: Napoleon, Arkansas, and Natchez and Vicksburg, Mississippi. Yet, none of these were completed before 1850. Most saw their major service in the Civil War. All but two were defunct by 1872. Ironically, the Napoleon hospital crumbled into the river as a direct result of the wartime activities of the U. S. Army and its engineers.

Two disastrous floods of the 1840's sparked a brief but crucial interest in the question of flood control within the lower valley. Congressional acts of 1850 and 1852 appropriated $100,000 to conduct a survey of the Mississippi Delta with a view toward determining the most practical means of preventing the recurring floods. The result was actually two surveys instead of one.

The first survey, conducted by a noted civilian engineer, Charles Ellet, Jr., had little impact upon public thought. His final report was couched in general terms; technical data to support his conclusions were conspicuously absent. Ellet did agree, however, that flood control in the Mississippi Valley was the responsibility of the entire nation, and his recommendations foresaw a comprehensive plan of flood control for the Mississippi River Valley that utilized a combination of levees, reservoirs, and outlets.

The second survey funded by the appropriations of 1850 and 1852 resulted in a report that was to become a classic work in the field of hydraulic engineering. Published in 1861, the *Physics and Hydraulics of the Mississippi River* detailed the findings and conclusions of Captain A. A. Humphreys in partnership with Lieutenant H. L. Abbot, both of the Corps of Engineers. In spite of its impressive and thorough scientific approach, the Humphrey and Abbot report was regrettably narrow in its conclusions. Its advocacy of the theory that levees alone would prevent the inundation of the lower Mississippi was to have great impact upon flood-control activities and seriously delay the implementation of a comprehensive approach to the problem.

A second incident of major import occurred at the close of the 1840's which intensified the demand, as well as the need, for public improvements. The California Gold Rush of 1849 magnetized the attention of the Nation. An enthusiastic Congress passed an immediate appropriation for surveys west of the Mississippi. Engineers were dispersed into hostile and friendly Indian territory alike, charged with locating sites for wagon roads and military posts. Some authorities advocated ship canals and railroads across Central America as a safer, more feasible, route to

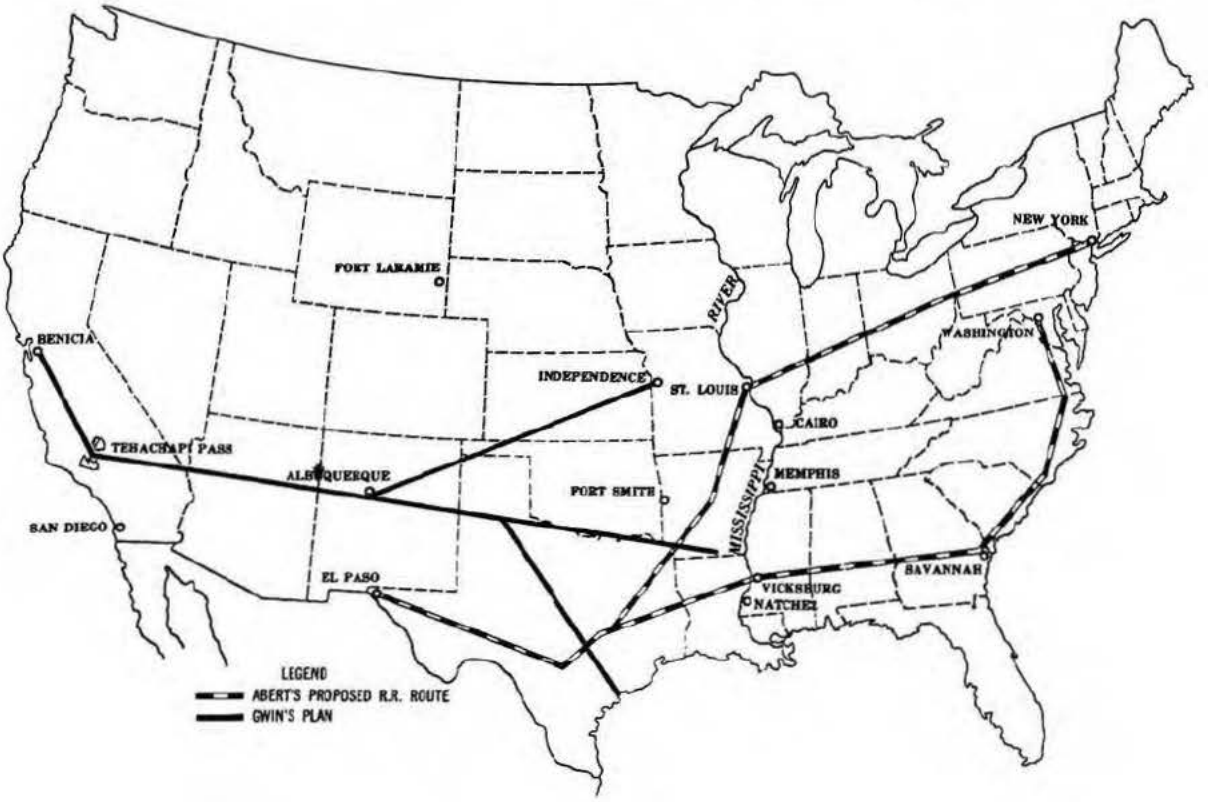
A. A. Humphreys

Henry L. Abbot

John J. Abert

California. Others, such as the Chief of the Topographical Engineers, Lieutenant Colonel John J. Abert, were convinced that the best route would be a transcontinental road and rail route, preferably through the southern part of the United States. As Abert envisioned it, the road would "avoid the danger of war while binding the country together politically and commercially."

In every public forum, Abert urged this combination of road and railroad across the United States, basically along the 32nd parallel. His proposed route had the further advantage of helping to police the southern border. The Abert route stretched from the Pacific Coast to the Rio Grande and across Texas until it cut the great fork of the Neches River at Nacogdoches, from which a



Joseph E. Johnston

southeastern branch of the road would proceed to Vicksburg, Savannah, Charleston, Wilmington, Norfolk, and Washington. A northeastern branch would connect Nacogdoches with Little Rock, St. Louis, Pittsburgh, and New York.

Abert's design, in all respects, was conceived as a national road which would establish an extensive economic network connecting all parts of the country and all major waterways. Yet, his plan met with considerable opposition. Numerous towns along the Mississippi vied to become an eastern terminal and crossroad of the transcontinental railroad and the Mississippi River. Within the lower valley alone, New Orleans, Natchez, Vicksburg, and Memphis were leading contenders. The issue was not only intersectional but intrasectional as well. Vicksburg, for example, not only was a rival of Chicago but was also in perpetual competition with its close neighbor, Natchez.

At least eight different routes were considered major possibilities in 1853. Two of these, the 32nd parallel route advocated by Abert and a 35th parallel route known as the Gwin Plan, involved the area that was to be encompassed by the Vicksburg District of the Army Engineers. Moreover, the 32nd parallel route had the additional support of the Atlantic and Pacific Railroad, which publicly announced its plans to construct a railroad from Vicksburg across Texas to El Paso and then along the 32nd parallel to California. The 1852 appointment of a high-ranking Army officer, Joseph E. Johnston (later Chief of Engineers for the Confederate Army) to the position of Chief Topographical Engineer in Texas emphasized even more clearly Abert's confidence that his route eventually would be chosen.

To settle the dispute, the 1853 Congress authorized an expenditure of $150,000 to survey all practical routes. Secretary of War Jefferson Davis was instructed to dispatch survey teams to not only explore and reconnoiter but also assess the proposed routes from every engineering and scientific angle. The surveys accomplished little. Several routes proved to be equally satisfactory. Other factors, obviously, would have to be considered. The decision was delayed throughout the 1850's. With the eruption of Civil War, the plan was temporarily shelved.

Still, the laborious surveys of the United States Army Engineers had not been without value. Their geographical findings proved to be of great use to the transcontinental railroads that eventually were built. Indeed, their activities generated much of the public demand for such access roads—a demand that war might suspend but never stifle.

ARMY ENGINEERS AND THE CIVIL WAR

With the outbreak of Civil War in America, the Engineers assumed an even more important role. Numerous officers on both sides of the conflict were Engineer officers or former Engineer officers. Robert E. Lee, Amiel Weeks Whipple, John Pope, A. B. Gray,

The many hills and ravines surrounding Vicksburg earned it the name "Gibralter of the Confederacy"

George Gordon Meade, G. H. Warren, A. A. Humphreys, Gustavus Smight, P. G. T. Beauregard, G. B. McClellan, John C. Fremont, James McPherson, Kirby Smith, H. L. Abbott, and W. B. Franklin were all trained at the United States Army Academy at West Point and had made significant contributions to the development of America through their engineering skills.

Martin Luther Smith, Chief Confederate Engineer at Vicksburg, and Joseph E. Johnston, former Chief Topographical Engineer for the United States Army in Texas, were particularly notable in the Vicksburg siege, as were Kirby Smith, W. B. Franklin, and William H. Emory who later took part in the 1864 Red River Campaign.

Traditionally, supporting the conduct of warfare has been the primary *raison d'etre* for a corps of military engineers. Such civil activities as it had heretofore conducted were viewed as a means of maintaining and improving the skills it needed to defend America in such emergencies as the War of 1812 with England and the Mexican conflict of the 1840's.

During America's civil conflict, the Corps of Engineers was thrust into an even more demanding position. Men who had trained together in the same engineering school now pitted wits and skills against each other. The degree to which each side was able to anticipate the designs and tactics of the opposition was certainly responsible to some extent for the lengthy duration of a conflict both sides believed would be brief.

Almost every aspect of the war demanded some degree of engineering skill. Bridges and roads frequently had to be built for the movement of troops. Temporary in nature and hastily constructed of necessity, these works of the military engineers displayed considerable ingenuity. A *mélange* of available material was put to use. Boards from homes and buildings, trees, and cotton bales were all converted into bridges over such Mississippi waterways as Bayou Pierre and the Big Black River. In the movement of the Army of Tennessee from Milliken's Bend to the outskirts of Vicksburg, for example, twenty-two various types of bridges had to be constructed.

The Vicksburg Campaign itself was a test of mettle, imagination, and finesse. Numerous experiments were contrived on both sides. Success did not always result, but the experience and the technical knowledge of the area that were gleaned in these attempts later proved to be of considerable use to the Corps in their development of the Vicksburg District.

A contemporary sketch of Grant's canal works at Delta Point

The Mississippi River was vitally needed as a transportation route by the Union forces, but in the first 2 years of war Confederate guns stationed on the strategic bluffs at Vicksburg effectively prevented Union boats from using the Mississippi. In 1862 a plan was conceived to circumvent Confederate guns at Vicksburg by changing the river's course. At the request of U. S. Army General Benjamin F. Butler, canal work began in June 1862 by the Army Engineers under General Thomas Williams. It was believed that a cut 4 to 6 feet wide and about 5 feet deep would lure the river from its main channel during the next rise. The currents then would scour the cutoff to sufficient depth and breadth for the passage of Union boats.

Twelve hundred slaves were "requisitioned" from nearby plantations, enticed by promises of freedom. The project began but progressed slowly, the work stymied by the usual problems. Illness felled the northern soldiers as they labored unaccustomed to the intensity of the southern climate. Mosquitoes were an incessant plague. The hard clay soil stubbornly resisted the army's tools. Shortages of food and medicine weakened the bodies and spirits of all the laborers, soldier and slave alike. Worst of all, the river fell instead of rising, and it fell faster than the laborers could dig. The banks collapsed, and the aborted canal was converted into a defense position.

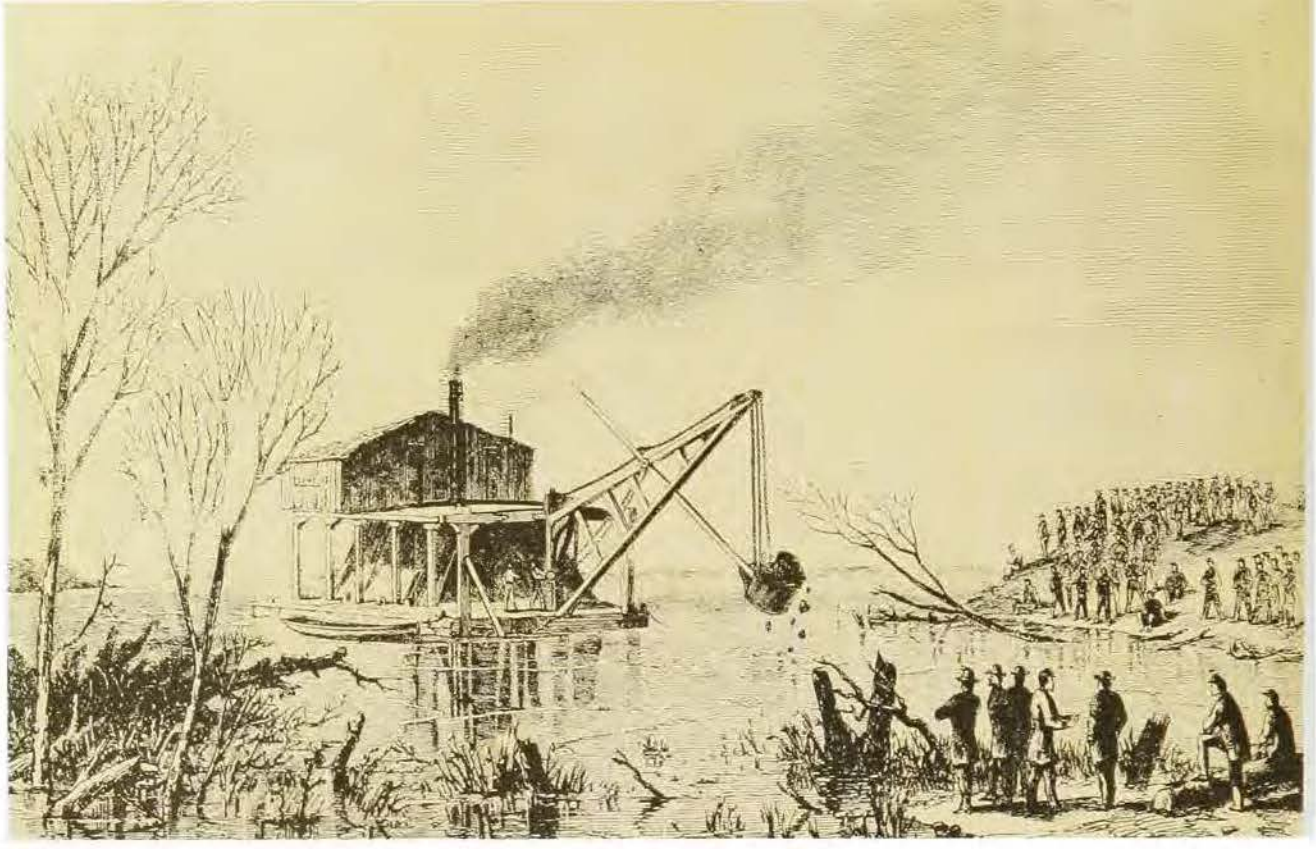
The Samson was deployed at the canal works near Duck Point

Still, the Union leaders remained convinced that the cutoff plan was a sound one. The Engineers responded to a second request and began work on a new canal. Again a race ensued between diggers and the falling level of the river. Laborers subsisted on salt pork and moldy hardtack, and the waters of the muddy Mississippi provided the only liquid available to replenish that drained by the searing summer heat. Diggers fell even faster than the plummeting water level. In mid-July, with a shaded thermometer bouncing between 110° and 115°, the project was abandoned.

The second campaign against Vicksburg, in 1863, stimulated a renewed effort to divert the Mississippi. At the suggestion of President Lincoln, the army of Ulysses S. Grant reluctantly began to cut a canal across the neck of land known as Young's Point, just opposite the beseiged city. Capable engineers directed the laborers, slave and soldier, whose numbers climbed as high as 4000 men. Cognizant of the previous disastrous experience, Army Engineers began this work in the dead of winter, hoping to complete the canal before the rise of the tropical sun and the fall of the river's crest.

A corduroy road had to be built across the marshes to provide access to the canal site. Racial tensions were high as northern and western soldiers openly displayed their contempt for the slaves who labored beside

Corduroy road



The dredge Samson gives support to the canal effort

them. Working in mud and water up to their knees, the diggers threw the dirt from their shovels to the sides of the canal, building a levee-parapet that would help to protect them from an overflow as well as enemy fire. Eventually, water flowed into the Union-made canal, but the river refused to scour its channel deep enough for the passage of Union boats. The following lyrics by Daniel D. Emmett poked fun at Grant's feeble attempts to change the Mighty Giant's course:

Grant marched his men, worn out and jaded
To Vicksburg where he was blockaded;
He dug a canal (none dare dispute him)
The river would not rise to suit him.

Work began anew to widen the narrow channel of the canal; at least 60 feet of breadth was needed. Confederate forces positioned their batteries on the bluffs opposite the canal's mouth and two-thirds of the work site fell within range of their guns. Torrential rains made the cold weather even more uncomfortable. Epidemics swept through the labor camps. Two dredge boats were brought in from Helena and Lake Providence to hasten the canal's completion. Success appeared imminent. Then on March 8, the protection levee broke and two months work was washed away by the sweeping waters.

Anticipating a possible failure with the Young's Point Canal, General Grant had chosen an alternate site. Lake Providence, 60 miles above Vicksburg on the Louisiana side of the river, once had been an old bed of the Mississippi. A natural cutoff had turned it into an oxbow lake with outlets that stretched into four major rivers. Utilization of Lake Providence would provide Federal gunboats on the Mississippi with a detour around the Confederate guns at Vicksburg.

The first stages of the proposed detour presented an obstacle course that none of the Federal craft could run without considerable preparatory work by the Engineer Corps. A mile-long canal had to be cut to connect the lake with the Mississippi River. The levee that local inhabitants had erected for their own protection would have to be cut also.

Canal at Delta Point

Too, the major outlet of Lake Providence, Baxter Bayou, was a narrow, winding, log-choked stream, its banks thick with overhanging trees. Eventually it fed into a cypress swamp before reaching the next outlet, Bayou Macon. The banks of Baxter Bayou, as well as the stream, would have to be cleaned of trees and debris by the Army Engineers before their snagboat could enter Bayou Macon. Dredging would also be necessary through several portions of the route. The canal was dug; the levee was cut. The onrushing waters not only filled the canal but flooded the lake and deluged much of the army's camp site. Federal forces were evacuated to higher ground.

Above Lake Providence, near the Arkansas line, a second possible point of entry into Bayou Macon existed. Only 3 miles of land separated the bayou from the Mississippi River at the village of Ashton. Army and naval commanders examined the site and concluded that a cut in the levee at this point would also flood the surrounding countryside enough to enable Federal gunboats to pass from the river directly into Bayou Macon. Engineers were dispatched to the site, the levee was blasted, and the Mississippi ate out the huge crevasses predicted. Yet, the floodwaters failed to reach anticipated heights.

On the opposite side of the Mississippi River twisted another line of connecting lakes and rivers which offered a possible water approach to the back of Vicksburg. Studying this route, Grant conceived what has been called the "most gigantic flanking movement ever attempted in military history." Behind and slightly above Vicksburg, the Yazoo River snaked forward, fed by the Yalobusha, the Tallahatchie, and the Coldwater. In past years, a 10-mile stretch of bayou, known as Yazoo Pass, had connected the Coldwater with the Mississippi at a point 150 miles above Vicksburg, but the rushing waters of the Mississippi often spilled over the banks of this short bayou and flooded the surrounding countryside. As protection, the local citizens had erected a formidable levee (1152 feet long,

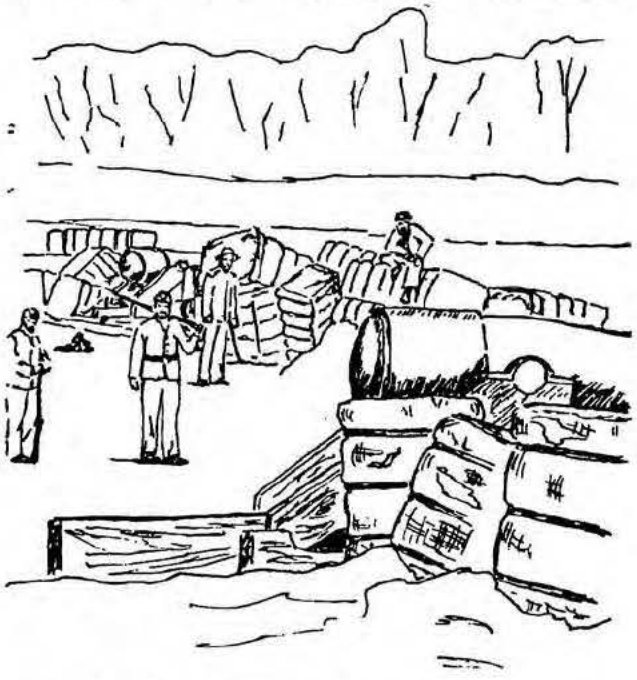
John C. Pemberton

28 feet high, with a base of 300 feet) which blocked the floodwaters of the Mississippi, as well as its vessels, from the Coldwater-Yazoo River system.

Upon his arrival in the area, Grant ordered his engineers to open Yazoo Pass. The levee was blasted, and the rushing waters soon cut a channel of navigable size. Federal vessels sailed into the pass but came to an abrupt halt. Confederate forces had anticipated the move and had closed the bayou with interwoven barricades of trees felled from the dense forests that bordered the route. While Army Engineers were engaged in the removal of this new obstruction, Confederate engineers erected an earthwork and battery of guns at a strategic point downriver.

At Fort Pemberton, as this Confederate stronghold was called, the Federal fleet again was halted. Assaults on the fort proved ineffective.

Another Mississippi River levee was cut to the north in hopes that the rising backwater would flood the fort. This too failed and Union boats retreated. United States strategists then charted an alternate route through a series of smaller bayous, a route that would bypass Fort Pemberton, and the Engineers again set to work clearing it. Once more the Federal



Fort Pemberton, the cotton bale fort

Federal transport attempting to run the rebel defenses at Vicksburg

vessels were turned back by Confederate engineers who blockaded the route with fallen trees and fortified the adjacent banks.

Undaunted, Grant sought yet another route. Above Vicksburg, at Duckport, Louisiana, the Mississippi River levee again was blasted and a canal cut to join the Mississippi to a series of Louisiana bayous that fed into the Mississippi again below Vicksburg. Engineering efforts were effective. Several U. S. boats successfully navigated the entire route, but then the water began to fall, leaving other vessels grounded. As the river fell, the flooded land routes around Vicksburg began to dry, and it was by land that Grant succeeded in taking the beseiged city.

At least one attempt by Union forces to dig a useful canal in the Vicksburg region did prove successful. Beulah Bend (now Lake Beulah) at Napoleon, Arkansas, had been a favorite spot for Confederate guerillas who sniped at enemy boats. Federal craft that entered the bend made targets of themselves—not once but twice—since snipers could fire upon them at the point of entry, cross the narrow neck of the bend (which was less than a mile wide) and then attack the same boats as they came out of the bend.

Army Engineers were quick to note the caving banks eating already into the neck of Beulah Bend. Digging a canal across the neck, while Confederates were deployed elsewhere, proved to be relatively easy. The main currents of the Mississippi quickly adopted the new canal and a full-fledged cutoff was effected. Within 24 hours of its opening, a United States craft steamed through the canal.

As a result of this change in course, the river began to eat away at its banks below the village of Napoleon. Unable to stop the encroachment, the populace began retreating. By 1869 the new marine hospital built by Engineers in the early 1850's was being threatened, and the county officials who were renting it for office space had to move. By the time the river reached the back wall of the building, in 1874, the county seat had moved 15 miles away to a safer community. In the face of eroding banks and ever-increasing flood levels, the entire town of Napoleon was abandoned. Ultimately, it caved into the river.

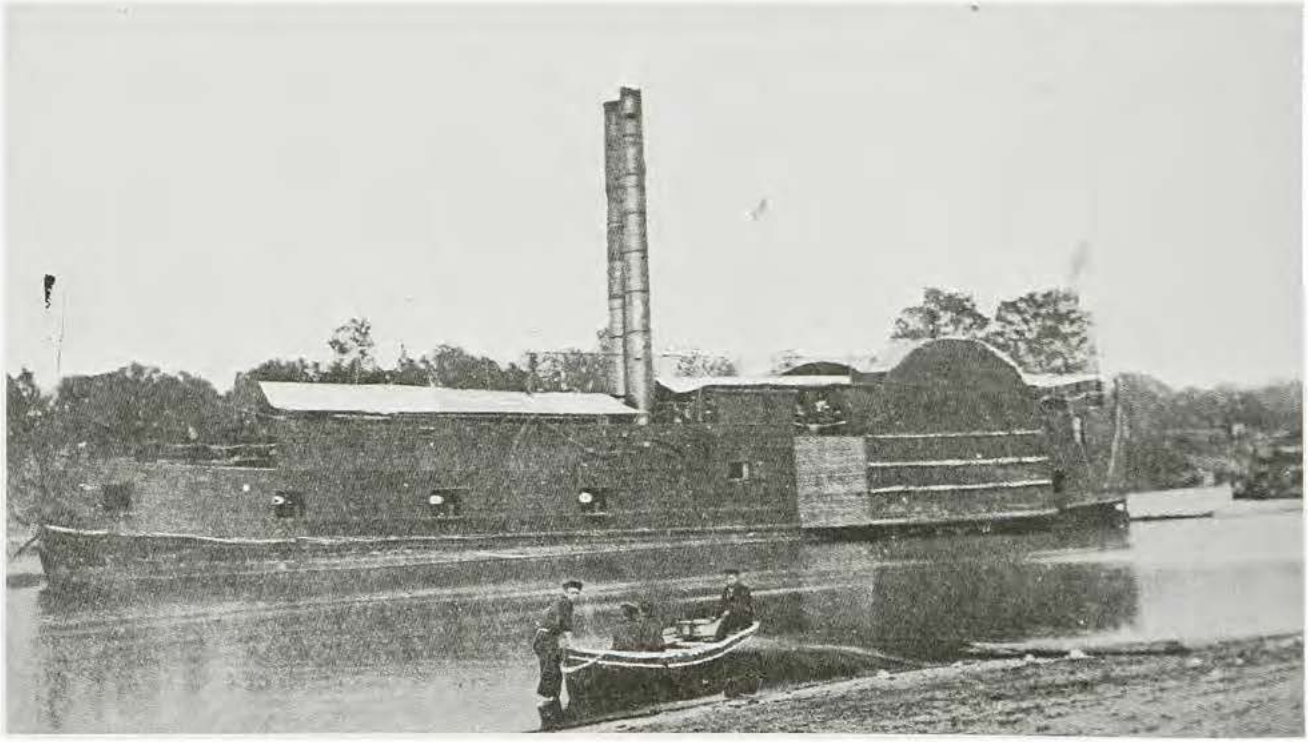
Of the wartime feats accomplished by Engineers within the territory that would one

David D. Porter

David G. Farragut

day become their Vicksburg District, the most heralded was undoubtedly the construction of Bailey's Dam on the Red River near Alexandria, Louisiana. In the spring of 1864, Union forces blazed their way up the Red River into the heart of Louisiana on their ill-fated Red River Expedition. As the river rose from spring rains, the fleet of Admiral D. D. Porter sailed safely over that mile of rocky ledges above Alexandria that long had been called "the rapids," and the expedition continued northward.

Within a month, however, the Red River Campaign came to a decisive halt. Union forces yielded at the Battles of Mansfield and Pleasant Hill, and a sudden fall of the river forced their rapid retreat. Porter reapproached the falls only to find them no longer navigable. The army force which had supported the naval fleet along the banks of the river was needed elsewhere. Yet, its abandonment of the navy, at a point from which it could not retreat, would have insured the fleet's destruction by Confederate forces.



The ironclad Lexington *accompanied Farragut on his expedition up the Red*

The **U.S.S. Hartford,** *one of the Union Vessels which secured the river following the fall of Vicksburg*

Lieutenant Colonel Joseph Bailey and other officers of the U. S. Engineers responded to the emergency with alacrity. An ingenious scheme was devised which increased the water's depth significantly across the rapids through the construction of a series of cribs, chutes, and wing dams. General W. B. Franklin, also an engineer, approved the plan and placed Bailey in charge.

The falls were composed of two cataracts approximately 1-1/4 miles apart with a 7-foot fall at the upper end and a 6-foot fall at the lower. The channel was both crooked and narrow and approximately 3-1/2 to 4 feet deep in places. A deep pool of water connected the two falls. Bailey's original plan called for one dam at the lower end to raise the water level over the upper falls and form a chute through the lower one. Its construction, however, brought only a partial alleviation of the problem. A second dam then was built to form a chute at the upper rapids. One vessel safely cleared both hurdles; two of the gunboats were grounded. An auxiliary bracket dam was constructed, and the remainder of the Union fleet safely negotiated the falls.

Construction of the entire system of dams, despite its trials and errors, had taken only 12 days, using 3000 men and a motley assortment of materials. Trees, brush, rocks, dirt and sand, brick and lumber from homes and warehouses, material and machinery from cotton gins and sugar mills, railroad iron, and barges had been combined with equal measures of unstinting labor and desperation to accomplish one of the most significant engineering feats of the entire war.

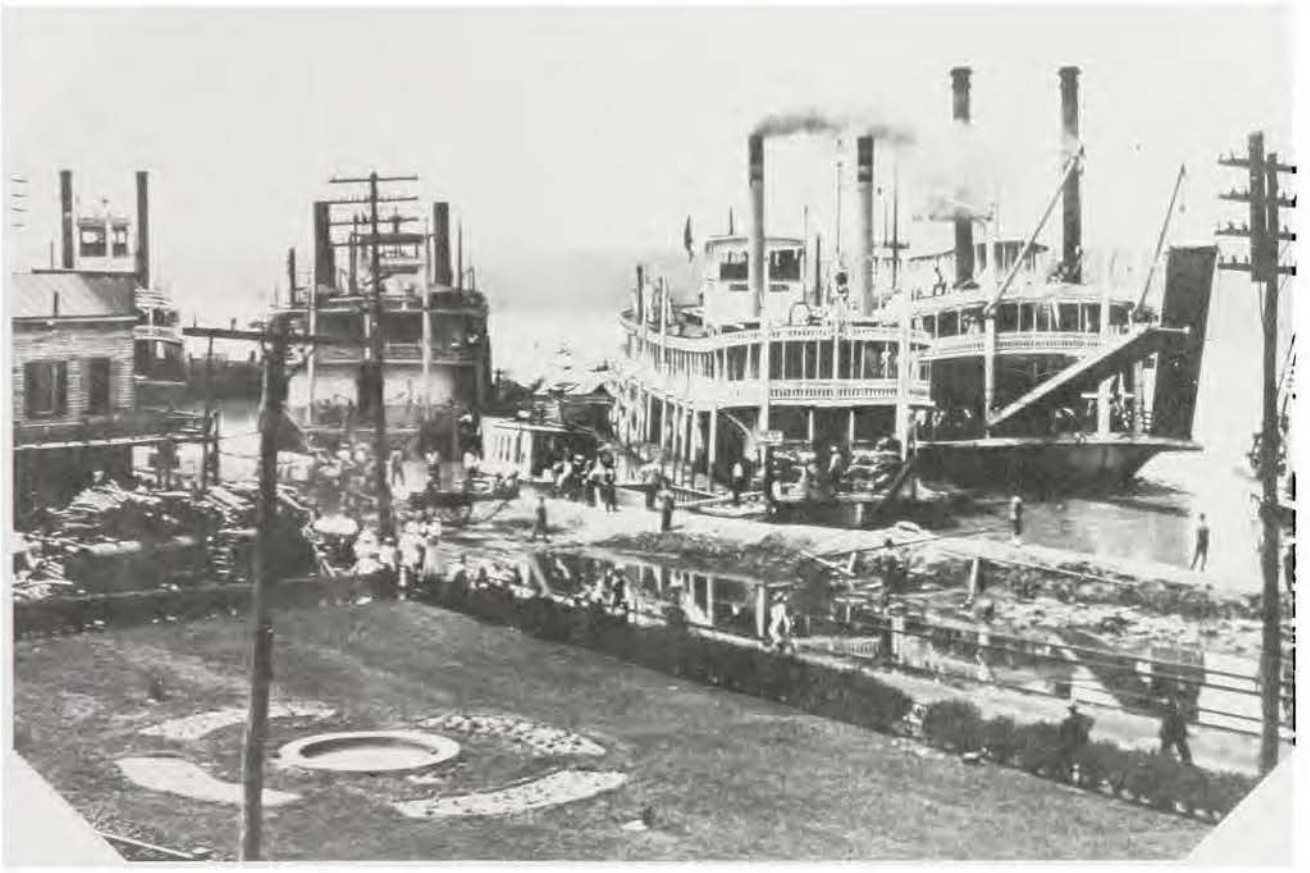
In general, the Civil War wreaked havoc upon the area that would soon become the Vicksburg District of the United States Army Corps of Engineers. A century and a half of flood protection works were destroyed purposefully, as well as ignorantly, by both sides. Those left standing were neglected by the very people whom they protected. A series

The famed Robert E. Lee, *legendary competitor against the* Natchez, *taking on cotton at Vicksburg after the war*

of serious floods throughout the war intensified the ever-worsening situation. The Mississippi Valley was left destitute and, without the meager flood protection of the prewar years, there was little hope of recovery. Postwar poverty, coupled with inefficient and often corrupt leadership, delayed the recuperation of the Valley for many years to come.

At the close of the Civil War, engineer work began anew in the Vicksburg region, although its purpose primarily focused upon the improvement of navigation. Surveys and reports were made on wrecks in all the major waterways of the area, with estimates of needed equipment, cost of removal, and recommendations of suitable methods for each. General reconnaissances, mappings, and geological reports continued.

Extensive studies were made of the reclamation of wastelands and the prevention of bank erosion and cutoffs, particularly at Vicksburg where the headstrong river threatened to abandon the city and wreck the extensive trade generated at that port. The possibility of erecting locks on the Ouachita also was investigated, and recommendations were made for deepening the channel of the Mississippi. Snagging and dredging operations halted by the war were resumed, and by 1870 river pilots were claiming that the

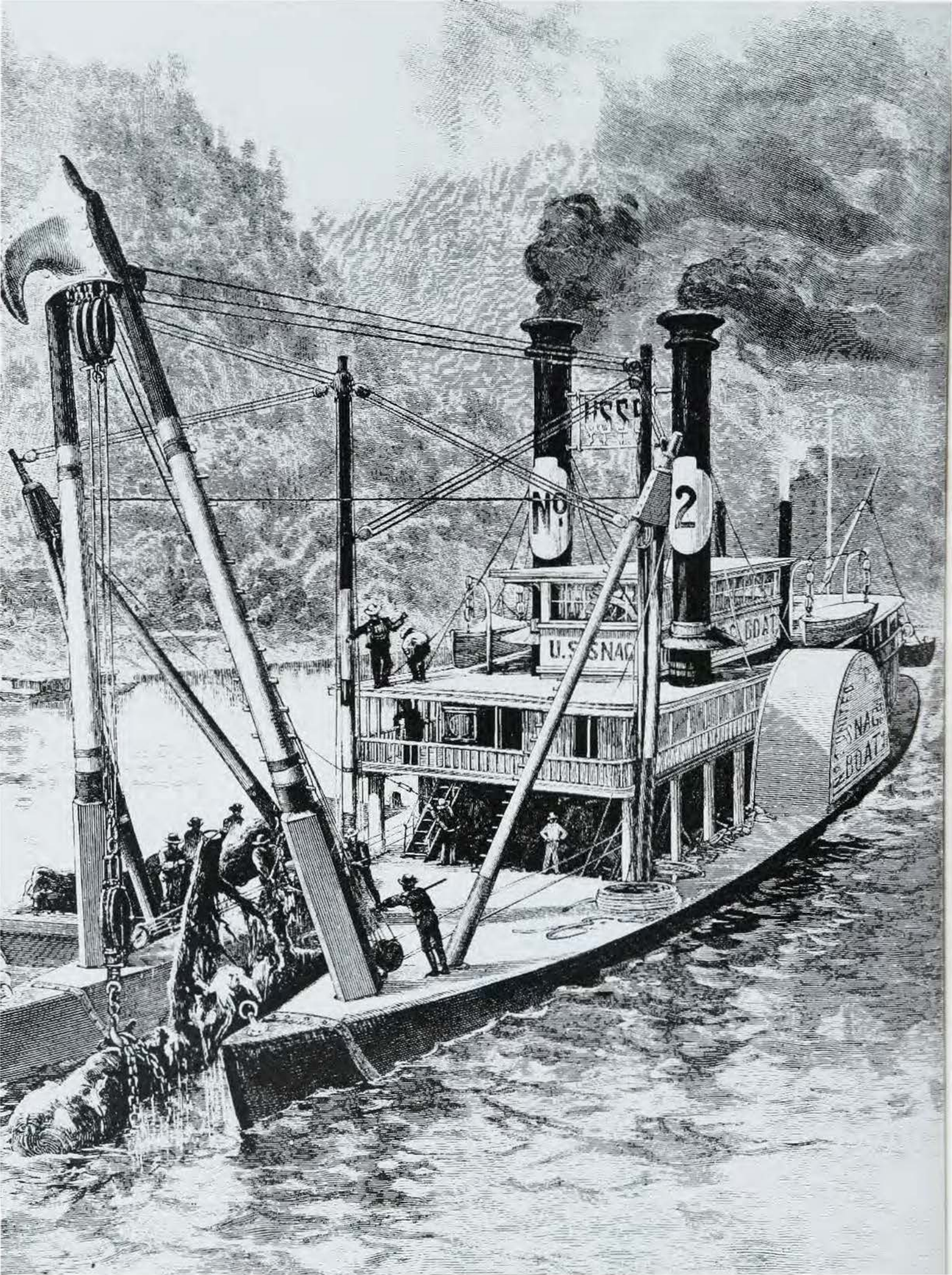


Federal transports were soon replaced by the more profitable merchant fleet of the 1870's

Mississippi River never had been in better condition.

Cognizant of its responsibility to restore flood protection works in the defeated territory, the War Department initiated an on-the-site investigation of the Mississippi River levees. A receptive Congress requested a copy of the report. The results were disheartening. General A. A. Humphreys, Chief of the Engineers, estimated the repair or replacement of almost 10,000,000 cubic yards of levee at a cost of $3.9 million. He also strongly urged that "the proper establishment and maintenance of the first order of levees requires some authority entirely beyond the influence of local interests."

The work of recovery had begun. The foundations were now laid for the initiation of concerted efforts by the United States Army Corps of Engineers. Within two decades, the Corps would become a permanent instrument of civil works development in the Lower Mississippi Valley. The city of Vicksburg, already a port of increasing importance, was destined to become the center of a vast engineering district that stretched from Central Mississippi to the territory of New Mexico.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U.S.S.NAG
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BOAT

Chapter II
THE FORMATIVE YEARS

The wind sings of a breed of men who tamed
the river's bank,...
Men of America, answering the call.

Hal Borland

A VICKSBURG DISTRICT EVOLVES

In the spring of 1873, the Office of Western Rivers Improvement dispatched one of its most capable engineers to the lower Mississippi Delta. The improvement of the Ouachita and Yazoo Rivers had begun on a permanent basis. Other area waterways would soon be added to the list of projects Congress annually assigned to the Corps. Aware of the difficulty of efficiently administering the work from the St. Louis headquarters, the Western Rivers Superintendent appointed Captain William Henry Harrison Benyaurd of the Engineer Corps to serve as his supervising engineer in the Yazoo and Ouachita Basins.

The 32-year-old Benyaurd already had compiled a distinguished record. A wartime graduate of the United States Military Academy, ranking sixth in his class, Benyaurd proved as adept in field service as he was in his studies. By the end of the conflict, he had been brevetted twice on the battlefield, first to captain and then to major, had filled the office of Chief Engineer of the Fifth Army Corps, and had earned the Medal of Honor for his "gallant and meritorious service" in the campaign against Richmond, Virginia.

Before leaving St. Louis, Benyaurd chose the small, seemingly progressive Louisiana town of Monroe as headquarters for his Ouachita-Yazoo work. He arrived at that port on 9 May 1873, with permission to rent an office at a rate not to exceed $60 a month, but he was immediately disenchanted with the area's opportunities and prospects. On the 30th of June, Benyaurd wrote directly to General A. A. Humphreys, Chief of Engineers, and requested permission for a change of station from Monroe, Louisiana, to Vicksburg, Mississippi.

William H. H. Benyaurd

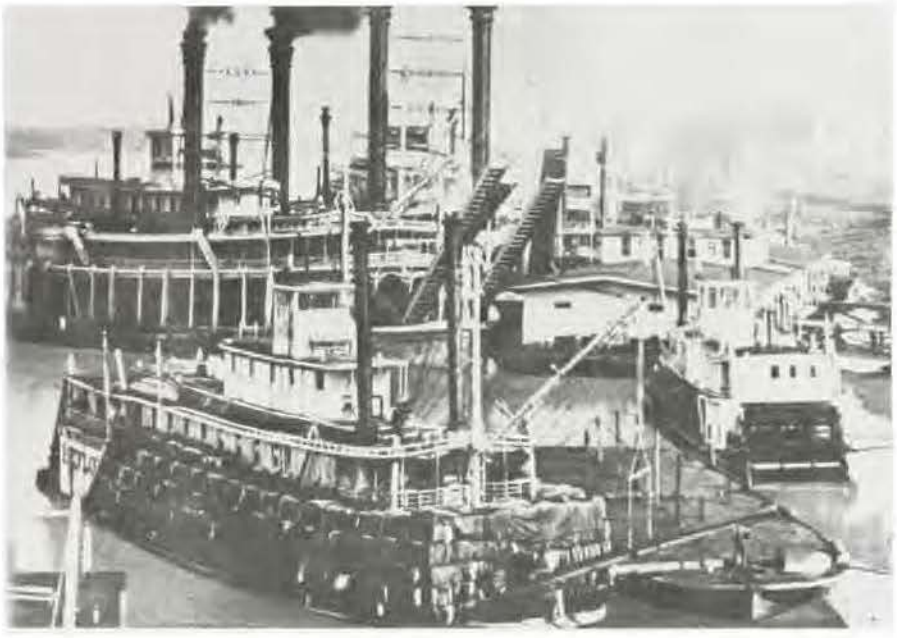
Benyaurd's stated reasons were numerous. Not only was Monroe small, but it had no business of importance. All of its commercial section and most of the residential portion of the town had been destroyed by fire the previous year, and the rebuilding of the community had lagged. The local merchants were not cooperative. They either would not accept government checks or charged a discount for doing so. There was no bank, and no one would give credit for more than a day. The local citizens even resented being asked to sign a voucher for money received.

Over on the Mississippi at its juncture with the Yazoo stood a town of considerably more importance. A picturesque and progressive river port, Vicksburg was a scheduled stop for all steamboats travelling to and from New Orleans. Also a rail terminal, it was widely recognized as one of the key transportation and commercial centers of the lower valley. Almost all of the goods needed by Benyaurd at the Monroe office had to be ordered from Vicksburg and shipped to his office on the Ouachita. Too, Benyaurd believed that his work would focus more on the Yazoo rather than the Ouachita. All things considered, the engineer deemed Vicksburg the ideal site for Corps headquarters in that region. With Humphreys' permission, the office was officially moved on 18 August 1873.

Each successive year saw an enlargement of Benyaurd's activities in the region that surrounded Vicksburg. Further clearing of the Red River raft was added to his responsibilities in 1875, along with the improvement of Tone's Bayou and Cypress Bayou (two major outlets of the Red) and the construction of a dam at the foot of Sodo Lake, also on Red River. In addition, Benyaurd was charged with the supervision of the water gages on the Mississippi and its tributaries, a project vital to the maintenance of safe navigation.

Subsequent years saw the addition of harbor work at the ports of Vicksburg, Memphis, and Natchez, and the improvement of additional rivers in Louisiana, southern Arkansas, Mississippi, and southern Tennessee. In the 10 years of Benyaurd's tenure, his responsibilities swelled from two projects to twenty-two. By the end of his tenure (1882), he had under his command at least seven assistant engineers and two snagboat captains. All of the work which they conducted, with the sole exception of the Memphis harbor, was within the limits of the area subsequently designated the Vicksburg District.

As his responsibilities increased—and quite probably as a result of the unhealthy conditions prevailing in the lower valley—Benyaurd restationed himself at Memphis and left the Vicksburg office in charge of his



As an important riverport, Vicksburg provided a better business atmosphere for the newly founded Engineers' Office

assistants. Life in the Vicksburg region was deemed especially unhealthy for those not acclimatized to the heat and endemic diseases. As a Pennsylvania native, Benyaurd was particularly susceptible. He succumbed to yellow fever during his tenure, and his health was seriously impaired. This factor eventually terminated his service to the lower valley. In 1882 he was transferred to the north where he was granted extended sick leaves throughout the remainder of that decade.

During Benyaurd's tour of duty in the lower Mississippi Valley, a second engineer office was opened at Vicksburg under the auspices of the newly created Mississippi River Commission. By 1879 the need for navigation improvement and flood control along the Mississippi River was a generally accepted fact. It was also apparent that a central authority would have to govern all work done on this major waterway. On June 28 of that year, Congress authorized the formation of a seven-member commission of military and civil engineers to fill that need. The commission was given authority to direct all works along the Mississippi, and the regular Engineer Department of the United States Army was restricted to work on the tributaries. By 1882 the new commission had segmented the river into four operating districts. The Third District, headquartered in Vicksburg, extended from the mouth of Arkansas's White River to Warrenton, Mississippi, 10 miles below Vicksburg.

Upon Benyaurd's transfer in 1882, Engineer activities within the Vicksburg region were placed under the supervision of Major Alexander M. Miller. A West Point engineer also and descendent of a family that had served the United States Army with considerable distinction, Miller simultaneously filled the position of District Engineer of the Mississippi River

A. M. Miller

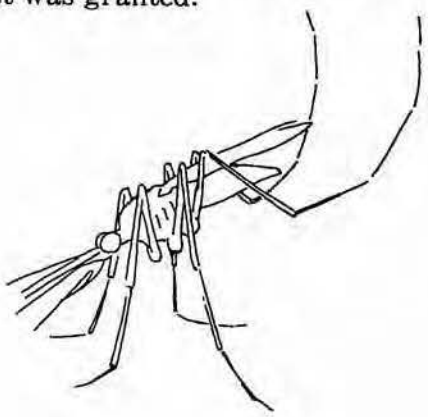
Eric Bergland

Commission's Second District at Memphis. His tenure in both offices was brief. Major Miller was transferred from the region in 1884, and a new supervising engineer for projects initiated by Benyaurd was dispatched to Vicksburg, Captain Eric Bergland.

Captain Bergland, a young Swedish immigrant at the outbreak of the Civil War, joined the 57th Regiment of Illinois Volunteers and was elected second lieutenant in spite of his youth and inexperience (he was seventeen). In the course of the war, he displayed such an aptitude for the martial arts that he was accepted at the United States Military Academy at the end of the war. His subsequent professional experience included both practical and theoretical application of the engineering principles learned at the Academy. Bergland not only had participated in the Western Rivers Explorations of the 1870's, but had taught at the Academy just prior to his assignment to the lower Mississippi Valley.

Upon his arrival in the area, Bergland moved the headquarters for work under his charge back to the Vicksburg Office. However, the new supervising engineer did exercise more caution than his predecessor. Memphis was a healthier location than Vicksburg; still, it was by no means immune to the Delta's endemic diseases. Bergland sought a late summer change of station that removed him completely from the vulnerable region.

In justifying his request, the new supervising engineer informed the Office of the Chief that area residents had warned him of the "sickly or malarious season" which began in August. Moreover, the hot weather often lasted until the end of October, he reported. "Those who have spent the summer north are sure to feel the effects of it if they return too early in the autumn." Too, since the beginning of June, the heat had been oppressive and the mosquitoes annoying, both day and night. With his operating funds almost exhausted for that season, Bergland felt it "questionable whether the best interests of the government require my presence here during the sickly season at the risk of loss of health and consequent loss of usefulness." Bergland's request was granted.



Steamer City of Camden *at work on the Ouachita River*

With only rare exceptions, Bergland's successors who served as superintending or district engineers in the Yazoo-Ouachita-Red River Basins would maintain their offices in Vicksburg also. Not until 1888, however, did the Corps of Engineers restructure its organization along the division-district plan, allowing the Vicksburg Office to become a formally organized geographical unit of the Corps.

In short, the Vicksburg District did not emerge as an absolute entity created specifically to conduct waterway improvements within given boundaries. Rather, it evolved over a period of a decade and a half, flexing its borders, juggling its responsibilities as well as its physical and financial limitations, and extending itself as Congress and public need dictated until a workable pattern developed for the conduct of an efficient and serviceable operation.

IMPROVEMENT OF THE OUACHITA BEGINS

When Captain Benyaurd, the first full-time engineer assigned to the Vicksburg District, arrived in the area, the Ouachita River was a major waterway. Steamboats ran regular schedules as far north as Camden, Arkansas, during certain periods of the year. The passenger accommodations of these steamliners were luxurious and their cargo spaces were designed to accommodate as many as 2000 bales of the cotton produced along the river's fertile banks.

Yet, the Ouachita was an unpredictable river. An early explorer once had sworn that

"few rivers differ more in the quantity of water at different seasons" than this river. In the spring, a veritable column of water flowed into its upper reaches from the hills and mountains above this river, but when the heat of summer scorched the Ouachita, its water shrank so low that few boats could navigate it above its juncture with Black River.

In 1870 Congress made its first appropriation for the improvement of the Ouachita, funding a survey and examination of the river to determine the best means of improving it. Subsequent appropriations while the examination was still in progress authorized snagging operations in the channel and the clearing of overhanging trees.

In 1872 the civil engineer who conducted the survey and examination of the Ouachita submitted a report in which he concluded that an extension of the navigable length of the river was feasible. His recommendations advised a series of five wooden locks and dams erected at strategic points between Trinity, Louisiana, and Camden, Arkansas. The depth of the river could be maintained, thereby, at a minimum of 4 feet throughout the year; the cost, however, would exceed a $1 million. The proposed project was approved by Congress, bids were let, and a contract entered into early in 1873.

Doubts soon arose over the reliability of the examination and recommendations of the civil engineer. At the request of the Superintendent of Western Rivers Improvement, the Chief of Engineers authorized a resurvey "to determine more definitely certain questionable points." Captain Benyaurd was then dispatched to the area to supervise personally the conduct of the new examination, as well as the channel clearing of the Ouachita and Yazoo.

Benyaurd's resurvey agreed that a system of locks and dams was the only feasible method of extending the navigable length of the Ouachita. At the same time, however, he questioned the advisability of conducting this improvement at all. His reassessment of costs estimated that the system would run just short of $3 million if the locks and dams were constructed of wood and as high as $6 million were they made of masonry. Even then, the larger boats on the Ouachita would not be able to navigate the Arkansas portion of the river. Benyaurd also noted that the volume of commerce on the Ouachita was not large enough to justify the expenditure of such a large sum, and that even the existing volume of waterborne commerce would diminish since a railroad would soon be opened to Camden. At the end of his first year in the region, Benyaurd recommended the abandonment of the project, and his suggestion was followed.

Cancellation of the lock and dam project did not mean the abandonment of navigational improvements on the Ouachita. As key factors changed over the years, new consideration would be given the lock and dam approach, and ultimately a more modern system of locks and dams would be constructed. In the meantime, however, the work of navigational improvement continued in a less controversial manner.

In 1871 Congress had made its first appropriation for the conduct of snagging operations on the Ouachita and the Little Missouri River which branched from it, and for the clearance of trees which overhung those channels. Problems had beset the work from

its very beginning. The Tennyson brothers, John and Thomas, were employed to captain the flatboats from which the work was conducted. In June 1871 John Tennyson reported:

> *I am now fairly at work after a hard struggle with the contract system. When I came here it seemed impossible to get anything done except by "contract" and contract here means money in advance, and work at leisure. I lost three days trying to get hauling done...*

Much of Tennyson's difficulty in outfitting his expedition resulted from the local attitudes that he encountered. The captain also reported:

> *Everything here in which the state or general government is concerned is looked upon with a suspicious eye, and I for one don't blame people who have been, to say the least, badly treated and I might add swindled at every corner by their state government.*

Tennyson also complained that he was forced to pay his laborers $40 a month. When his unskilled help failed to discern the difference between snags and logs, he tersely informed them: "Snags have stumps. Logs don't." Blasting of the overhanging trees was particularly vexatious. As holes were bored into the trees and packed with powder, water

Engineer maneuver boat, circa 1880

seeped through the wood and wet the powder. Only a few splinters and chunks would fly when the powder was lit. Consequently, the bulk of the obstructions had to be removed with the more primitive method of block and tackle.

Not until night, when the crew retired, did Tennyson stop long enough to keep his required journal. On September 6, John recorded:

> *This log is written at night. Bugs, gnats, etc. are hovering around the lamp and under the pen. But I consider that it is better that a few blots should occur on these pages than in the work.*

Daily hospital lists recorded in Tennyson's log noted workers inactive because of poison vines and axe wounds, as well as more general "ague and fever." A host of accidents and illnesses accompanied the survey. John Tennyson succumbed to "billious intermittent fever" caused by the "fearful miasma" of the region near the mouth of the Little Missouri. "We were in [the area] only two days, and came out with five men having chills, and all more or less affected."

Civil Engineer Clement Smith reported similar difficulties with the survey work under his charge.

> *The Negroes at work as boatmen are in the water constantly and require whiskey not only as a protection against sickness but to stimulate them to activity and perseverance. Will the Government allow me to get a supply to be issued daily by myself?*

Apparently the only light moments in the entire work on the Ouachita resulted from the competition between the crews captained by the two Tennyson brothers. Again, the New Jersey natives reported on their locally assembled crews early in the project.

> *"Brother Thos. has a colored crew," John noted, "I have all white. There will be a great rivalry between the two crews to test which can do the greatest amount of work....I tell Thos. that it is only skill against force, my crew having the most skill to work, while his will have the greatest endurance.*

Neither of the brothers reported the results of the competition at the end of the project. Apparently the performances of their crews were adjudged a draw. John Tennyson did note, however, that all of their men worked in harmony and that they worked 10 hours per day—although it sometimes required 11 hours on the job to complete 10 hours of work!

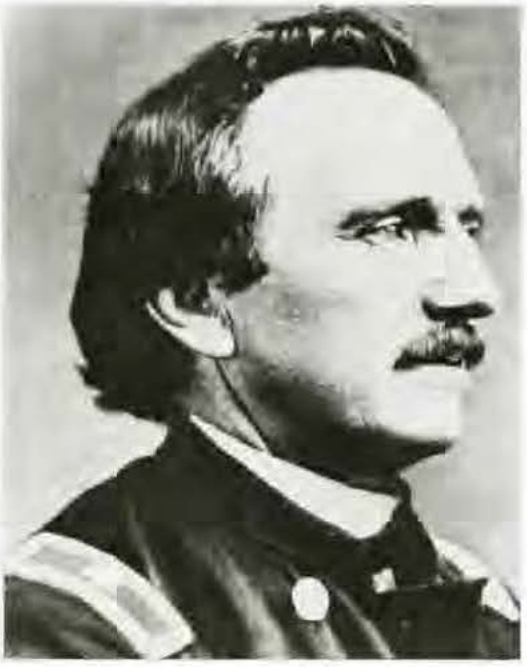
Continuation of snagging operations on the Ouachita brought new problems the following year. Sharp-eyed politicians viewed the Federal work as an opportunity to further their own political interests, as well as those of their party. A formal complaint was made to the Chief of Engineers by one Arkansas

congressmen who charged that "the appropriation of $60,000 for the Imp's [improvements] of the Ouachita River is being disbursed in such a way as to place power in the hands of our political enemies." The congressman then insisted that "one of our friends to be designated by us shall have the supervision of the matter" and went so far as to suggest his candidate for the post.

Upon receipt of the charges, Chief Humphreys requested the comments of General W. F. Raynolds of the St. Louis Office, who then had supervision over the work in the lower valley. Raynolds labelled the charges absurd; not one penny of the appropriations referred to had yet been disbursed; in fact, Raynolds had not yet been given the funds. However, since the subject had been raised, he did have a few general remarks that he wished to make on the issue of political involvements:

> *My understanding of the matter is hat all appropriations for public orks are intended for the objects specified and not for the advancement of any political party. With this understanding (although possessing emphatic personal political views), I have endeavored to discharge the duties committed to my care without fear, favor, or affection—aiming to secure the services of competent persons and have never asked the political views of anyone—and should I find any of my employees devoting himself to advancing the interest of a political party rather than the work on which he was employed, I should deem it good grounds for dispensing with his services.*

Strict adherance to the law in the dispensing of public funds was an issue of primary concern to General Raynolds and the Office of Western River Improvements. Raynolds' correspondence prior to 1873 is filled with cautions and admonitions to the Ouachita work parties, continuous reminders of the terms and conditions on which their funds might be spent. Vouchers were mandatory for all expenditures, the washing of clothes was not a legitimate expense, and reports had to be prompt. Expenditures could not exceed appropriations; an excess expenditure of even one dollar was a criminal offense under the law. Apparently, the difficulty of financially administering projects so distant, as well as the necessity of personally supervising the quality of the work, had compelled the St. Louis Office to locate a supervising engineer in that part of the Delta.



W. F. Raynolds

Captain Benyaurd arrived in the area to face a host of new problems. The El Dorado, Arkansas, citizen who had contracted to provide lumber for the lock and dam project proved to be a drunk. His timber was inferior and poorly stacked and sawn. A new contractor could not be found. The chief assistant engineer for the Ouachita's resurvey was likewise addicted to excessive indulgence in spirits. While a partial crew waited for his orders to begin work, the engineer began a week-long drinking spree. When he sobered, it was to order a base line drawn and a line of levels run that none of his men could comprehend. Only then did his coworkers report his misconduct to Benyaurd who promptly fired him.

The engineer's replacement quickly hired a new crew and attempted to make up for lost time. Half of his crew left after only two days of labor. "I think they imagined they were going on a frolic," the new chief assistant engineer reported to Benyaurd, "but found out differently. There was [sic] no accommodations for them, so I shall work with the present force until the tent gets here."

Benyaurd's efforts to clear the Ouachita of dangerous obstructions were likewise plagued with problems. A certain number of laborers always proved to be shirkers and faultfinders. Others died of congestive fever or accidents, in spite of the efforts of the project engineers to provide medical care and to maintain stocks of medicine while working in remote areas. Malaria and yellow fever plagued the crews. One death from disease would bring mass resignations among the hands. Even when the laborers were apparently well, local health boards forbade the work boats to stop in their areas because they feared that the crews might bring the diseases into their communities. The entire low-water season of 1878, the normal "working season" of the snagging crews, was lost when a yellow fever epidemic swept the lower Delta and claimed 14,000 lives.

The initial equipment issued to Benyaurd for the conduct of his work was primitive, to say the least. In 1871 two flatboats, only one of them steam-propelled, were outfitted with cranes for use in the Vicksburg region. They often proved unequal to the tasks they faced. The flatboat *Ouachita*, under the civilian captain Justin Straszer, began each season's work at the navigable head of the Ouachita and floated down with the current to the various worksites. If an emergency occurred above their location, it had to be ignored since the *Ouachita* lacked the power to move upstream. A rise in water could result in a delay of several days since the flatboat could not safely move.

Specific problems often arose that the *Ouachita* could not handle. In 1874 for example, Straszer arrived at Monroe to clear a mass of obstructions in front of that city's wharf-boat. At the close of his futile efforts, he reported to Benyaurd that the obstructions had consisted of bridge piers and a mass of timbers, all part of a turntable of a railroad bridge that had been partially burned during the late war and had fallen, subsequently, into the river. Straszer could not remove the piers. An attempt to provide sufficient crane power for the task would have capsized and sunk his own boat.

The inadequacies of Benyaurd's plant were partially alleviated late in 1874. Using funds from the aborted lock and dam project,

the supervising engineer ordered the construction of an iron-hulled and light-draught snagboat. After its first season of use, Benyaurd enthusiastically reported its construction to the St. Louis Office. The new boat was of enormous structural strength and stiffness and sported an almost indestructible hull. Moreover, it required only 2-1/2 feet of water, whereas the old wooden boats required a draw of 5 feet.

Citing the importance of adequate equipment, Benyaurd pleaded for two additional iron-hulled craft. The wooden snagboats were now "almost useless on account of their excessive draught of water and the yearly cost of keeping up their wooden hulls is a great tax upon the small annual appropriation." With new equipment, Benyaurd pointed out, "I should be able to make a far better use of even the small annual appropriations now granted us."

The major difficulty faced in the Ouachita project was the nature of the river itself. Benyaurd described it in 1874 as a "succession of pools and shoals." Between Camden, Arkansas, and Trinity, Louisiana, a distance of 294 miles, there were 65 shoals totalling 40 miles in length; in short, shoals constituted 13.5 percent of that stretch of the river. Although these obstructions were of small consequence in high water, they rendered low-water navigation a virtual impossibility. As navigation interests continued their requests for improvement of the Ouachita, Benyaurd recommended a series of low-water or wing dams at these shoals as a less costly alternative to the previously suggested lock and dam system. Wing dams, Benyaurd suggested, would concentrate all of the water into a single channel and thereby increase the depth of this channel at low water.

Construction of the dams began in 1877 at two strategic sites in Arkansas, Spoon Camp Shoals and Buffalo Flats. Constructed of willow mattresses, the dams were weighted down with rocks, sandbags, and water-logged timber placed against their pilings. To reduce costs at Buffalo Flat, Captain Justin Straszer hooked his new iron-hulled *Wagner* to an old sawmill that he owned and pulled the structure down. The salvaged timber was then put to use as binders and cross-stringers for the rafts and mattresses that they were building. The successful completion of these two dams drew a flurry of praise from rivermen and spurred the initiation of similar structures at other shoal sites along the river.

The damming of Ouachita's shoals was not an innovation. Engineers of the State of Louisiana had attempted their own dam at Catahoula Shoals before the Civil War, but they had placed their structure in a poor position. A portion of it had washed away by the 1870's. Benyaurd agreed that a dam was advisable at this point and proposed to repair

O. G. Wagner

COST ESTIMATES, 1880
PROPOSED LOCK AND DAMS AT CATAHOULA SHOALS

The cost of quarrying and delivering the first 1,000 cubic yards of stone at a point convenient for loading in barges:	
825 days' labor, at $1.25 per day	$ 1,031.25
825 days' subsistence, at 45 cents per day	371.25
20 wheelbarrows, at $4.50 each	90.00
50 crowbars and picks	112.50
Timber, bolts, nails, labor, etc., for chutes	300.00
Shovels	45.00
	1,950.00
Cost of loading in barges and putting in position in the dam, assuming 16 cubic feet to be the average day's work for one man:	
Wages and subsistence, $1.70 per day	2,868.75
Cost for first 1,000 cubic yards	4,818.75
Amount of cubic yards in No. 1, 2,833:	
To place 2,833 cubic yards in position, at $4.82 per cubic yard	13,655.06
Amount of cubic yards in No. 2, 1,977:	
To place 1,977 cubic yards in position, at $4.82 per cubic yard	9,529.14
Total cost of stone in place	23,181.20
To which must be added the cost of barges, superintendence, transportation, and other expenses incidental to a work of this kind.	
Five barges with a capacity for carrying 20 cubic yards of stone each, with suitable tackle and other apparel, at $150 each	2,250.00
For other items as named above	4,500.00
Total	6,750.00

RECAPITULATION

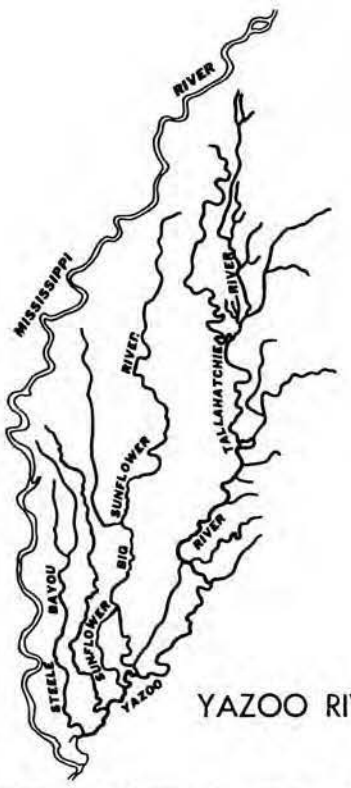
Cost of stone laid in Dam No. 1	13,655.06
Cost of stone laid in Dam No. 2	9,529.14
Cost of barges	2,250.00
Cost of other items as above	4,500.00
Total for Nos. 1 and 2	$29,934.20

and rebuild it, recommending the use of a stone lock and dam for this strategic site. His subsequent work, implementing these plans as closely as inadequate funds would allow, fulfilled expectations. With this one improvement, year-round navigation as high as Columbia, Louisiana, was effected.

Improvement of the Ouachita lagged after 1882. Congressional appropriations dwindled. Benyaurd was transferred, and the interim supervisor at Memphis—preoccupied with his primary duties as District Engineer for the Mississippi River Commission—neglected the distant Ouachita. Not even maintenance work was conducted. By the time that a new supervising engineer, Captain Bergland, arrived at Vicksburg, the Ouachita had refilled with landslides, wrecks, log jams, and sawdust dams near the numerous sawmills that dotted the river's banks. Bergland immediately refitted the *Wagner* and dispatched it to the Ouachita. Under his supervision, and that of his successors, a systematic program of maintenance work would continue on this waterway for many years to come.

THE YAZOO RIVER

Simultaneously with this work on the Ouachita, the first supervising engineer in the Vicksburg District was charged with the removal of wrecks from the Yazoo River of Mississippi and the clearing of other obstructions in its channel. A survey of that river, made the year before Benyaurd's arrival, reported no less than forty wrecks of gunboats and steamers that had been sunk during the late war, as well as others lost in the course of commercial navigation. Only

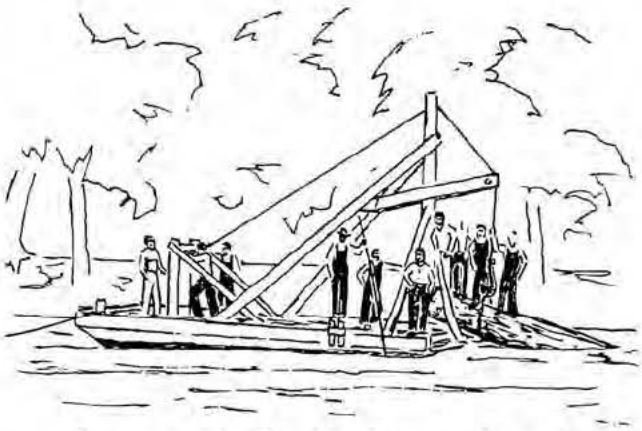


YAZOO RIVER BASIN

nineteen of these, however, were considered dangerous obstructions.

Work began on this project in late 1873 with the removal of those wrecks which Benyaurd's poorly equipped boats could handle. After the iron-hulled *Wagner* finished its first season of work on the Ouachita, it was transferred to the Yazoo for removal of the most dangerous portions of the *Capital* near Liverpool Landing and the *Star of the West*, 6 miles up the Tallahatchie. Further wreck removal on the Yazoo was delayed for 4 years; since the *Wagner* had been built with funds earmarked for the Ouachita River, Benyaurd could not transfer her to any other work as long as she was needed for the Ouachita project.

In the meantime, the captain pleaded for appropriations to build a second iron-hulled snagboat for the Yazoo work. The appropriations were never made. Out of Benyaurd's desperation, an idea mushroomed, and the supervising engineer took matters into his own hands. Each year, the funds appropriated for snagging of various small streams were combined and set aside, with the work being postponed until a sufficient amount was accumulated to build a light-draught boat for shared use in all the streams. The new craft, *John R. Meigs*, was completed in October 1879 and put to immediate work despite the lateness of the season.



In general, the hard-pressed engineers within the Vicksburg region adopted the same policy for the removal of wrecks—not only from the Yazoo but from all navigable streams—as they employed in the removal of other obstructions: a wreck was removed, partially or wholly, only when it became a threat to navigation. Like snagging, wreck removal was a continuous task. New wrecks occurred each year. However, it was a task with a foreseeable end, or at least a significant diminution. Each removal of a wreckage or a snag reduced the dangers of navigation, and the incidences of new wrecks showed a parallel decrease.

As a correlative measure in the prevention of wrecks, the expanding fleet of engineering boats in the Vicksburg District made its services available to privately owned craft in distress. In 1888 alone, the *Meigs* was twice engaged in rescue operations. In October of that year, the *Arkansas City*, a steam trading boat on the Yazoo, had hit a snag and was sinking rapidly when the *Meigs* answered its distress signal and freed it. Again that same month, the crew of the *Meigs* worked 7 hours to free the steamer *LeFlore* which had run aground at the Yazoo's Upper Gold Dust Bar.

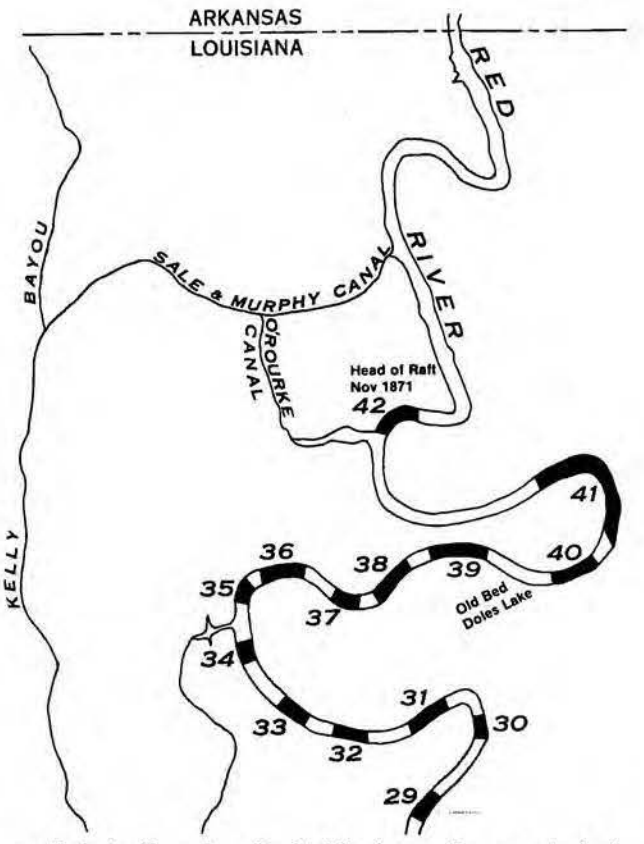
While lives were not seriously threatened in either instance, a sizable amount of money was at stake, not only for the boatowners but for the United States Engineers who would have had to remove the wreckages if the boats had been allowed to sink. Using the 1874 estimate of approximately $5000 per wreck as a base cost of removal work during this period, it is apparent that a few hours of preventive assistance to distressed vessels effected a long-run savings of considerable size.

RED RIVER REOPENED

Captain Benyaurd's efficient administration of the Yazoo-Ouachita work resulted in almost immediate expansion of his duties. The year following his arrival in the Vicksburg District, the Engineer Department transferred to Benyaurd's charge the Red River work initiated by the New Orleans Office—at the request of the supervising engineer at New Orleans, who felt the work was "too remote to allow that personal attention" he believed it deserved.

The Red River was plagued with navigational obstructions, not only snags and wrecks, but rafts and falls as well. Between 1828 and 1841, the Federal government had appropriated over $500,000 to finance the removal of the raft. Under the direction of Captain Shreve, the major portion of the raft had been removed, at least that part south of Shreveport. However, congressional failure to appropriate subsequent funds for maintenance resulted in the reformation of the raft in much of the cleared area.

As the waters of the Red backed up above the new raft and overflowed the surrounding farm lands, worried planters had sought help from the State of Louisiana. The legislature of that state appropriated $100,000 in 1852, but the sum was sufficient to clear only part of the obstruction. As the years passed and the floods increased, the hard-pressed planters persuaded the state to grant to them a charter under the terms of which they might sell stock to raise the funds for clearing the raft and then levy tolls for a period of 30 years to repay the stockholders. The charter was granted, the stock was taken by interested planters, and the



The U. S. Engineers faced a tightly jammed Red River in 1872 with rafts scattered as shown at right

work was about to begin when the war interrupted their plans.

In 1872 the Federal government again assumed responsibility for the destruction of the raft and authorized an examination and survey preparatory to the actual initiation of the work. The engineer in charge subsequently reported that the raft had grown to 32 miles in length. For over 7 of these miles, the raft covered the whole breadth of the river. Much of the obstruction was "floating raft" under which water could still flow; the extent of this portion was computed at 290 acres. Another 103 acres, however, was composed of towheads, a mass of timber extending the full depth of the river. Water-logged trees, stumps, and logs sunk into the riverbed. Mud conglomerated at its base and built itself upward until willows took root in it, and the growth of those roots then bound the mass together even more tightly.

U. S. Snagboat AID *participated in operations on the great Red River Raft*

The B. T. Bryarly

The Thomas B. Florence

Too, the situation was rapidly worsening. Navigation was dangerous throughout the length of the river at all seasons. The channel shifted frequently, and at flood stages the river overflowed the entire raft region. The banks were heavily timbered and each flood caused them to cave or slide. Removal of the raft would effect an estimated annual savings of $150,000 to the planting interests and relieve some 25,000 acres of productive land from frequent inundation.

The actual work on the raft involved a number of diverse activities. While craneboats, shearboats, and sawboats worked on the raft, the United States steamer *Sterling* cruised the river to prevent more jams and drifts. Shore parties with axes, saws, dynamite, nitroglycerin, and blasting powder tackled the outer fringes of the raft and the overhanging trees, as well as the trees that threatened to cave into the river.

By 1873 a channel had been cut completely through the length of the raft, and was kept clear of drift so the raft would not re-form while the remainder of the work was in progress. In removing the remaining raft sections, selective clearing was employed. While it was mandatory to remove the bulk of the raft, to prevent future accumulations, there were still portions which actually benefitted the channel's flow, by acting, for example, as a natural wing dam that confined and strengthened in places river velocity. These were assessed and altered wherever necessary to improve the currents.

For the Army Engineers and the civilians who assisted them, work on the raft was a seesaw of satisfaction and frustration, with occasional embarrassments. The value of their work was beyond questioning. The bulk of the planters along their route displayed considerable gratitude and pleasure for the work done. The Nation was less appreciative. Funds were perenially short, and the high wages paid to laborers each fall—to compete with the wages those hands could earn in the cotton fields—proved a sizable drain on their appropriations.

Captain Benyaurd's constant reminders to Washington that the nature of the river demanded sufficient annual appropriations for maintenance were routinely ignored. When an early summer freshet in 1876 brought an avalanche of new timber downriver that reclogged much of the cleared channel, the Vicksburg region had not yet received its appropriations for the year. Congress still procrastinated. By the time funds were provided, the newly formed rafts were as tightly packed and as difficult to remove as the old ones had been. Then, in attempting to carry out its work, the steamer *Florence* sank. Fortunately, she lay near the shore, in a favorable position for raising, and was recovered as soon as the water level dropped sufficiently.

Ax crew takes time from Red River operations to pose

Removal of the raft and stumps throughout the channel effected twin benefits. It not only improved navigation, but also decreased the pressure that the currents exerted on the river's banks; shore lines caved much less frequently. The increased flow then scoured the riverbed, deepening the channel, lowering the flood levels, and improving area drainage in general. A great deal of valuable agricultural land was reclaimed.

While the majority of area residents were appreciative of the Engineers' river improvements, the sentiment was not universal. Some of northwest Louisiana's citizens were fearful of the methods being used. Others who lived along the outlets of the Red felt that increased waters in the back-country bayous had benefitted them. Still others, particularly the lumber interests, sought to foist upon the Corps certain responsibilities that were definitely their own.

The continuous use of explosives created a pervasive sense of uneasiness among much of the crew as well as area residents. Some feared dynamite; Captain John Tennyson refused to allow it on his boat. Others were apprehensive over the introduction of 1000 pounds of nitroglycerin in February 1874. Their apprehensiveness was certainly intensified later that year when a store of nitroglycerin and dynamite exploded in an Engineer-leased depot 4 miles from Shreveport. The blast rocked the town. Residents fled into the street, "amazed and bewildered," afraid that an earthquake was bringing down the walls of their homes. A fisherman less than 50 yards from the site was severely shaken, his life saved only by the 18 to 20 feet of riverbank between him and the shed. Where the depot had stood, the ground was funneled into a pit 9 feet deep and 20 feet in diameter.

The cause of the blast never was determined. Arson was suggested, and the possibility was not discounted entirely. The instability of the explosives themselves seemed to be the most reasonable explanation, and Captain Tennyson remained convinced that the dynamite rather than the nitroglycerin was responsible. Tennyson had consistently checked each new batch of nitroglycerin that

arrived, by filling a 2-pound can with that volatile substance and throwing it as far as he could. None of the nitroglycerin manufactured for use on the Red River had exploded during his tests. Furthermore, he had made it a general practice to keep the nitroglycerin washed to prevent acid buildup.

It was the general concensus of most engineers on the scene that the nitroglycerin would be the better explosive for use in the remainder of the project. As long as it was tested, washed occasionally, and handled with care, it was a dependable explosive. Certainly it was safer and more economical than the gunpowder which earlier engineers had used routinely.

As the maintenance work of the Corps increased along Red River and area residents came to expect and depend upon the channel clearing activities of the Engineers, certain members of the timber industry sought to reduce their own operational costs at the expense of the Corps. Lumbermen long had been in the practice of floating rafts of timber downstream from the cutting sites to the sawmills. Hands were employed to oversee the rafts and prevent them from jamming and forming obstructions. In 1880 Benyaurd vociferously complained of one company in particular that had begun to float off rafts without adequate supervision, knowing that if they jammed, the Corps would feel obligated to dislodge them and send them on their way again. When the responsible parties failed to correct their negligence, Benyaurd was forced to seek legal action to prevent recurrences.

Not all area citizens were in favor of the raft's removal. Residents of the lower valley of Red River long had looked upon this vast upriver obstruction as a natural dam which helped protect their lands from overflow during flood seasons. Residents of the upper reaches of the river, particularly those in the backlands, were delighted when the downriver raft caused floodwaters to back up into bayous and lakes and create navigable waterways where they would not exist normally.

The town of Jefferson, Texas, owed much of its existence to the presence of the raft above Shreveport. Jefferson was situated on Cypress Bayou, a small tributary of the Red. Floodwaters above Shreveport backed into a series of lakes and bayous that streteched between Shreveport and Jefferson, and provided the Texas city with a navigable water route.

Since Shreveport was the navigable head of the Red River, commercial boats used Cypress Bayou extensively to haul commodities into Texas, and the town of

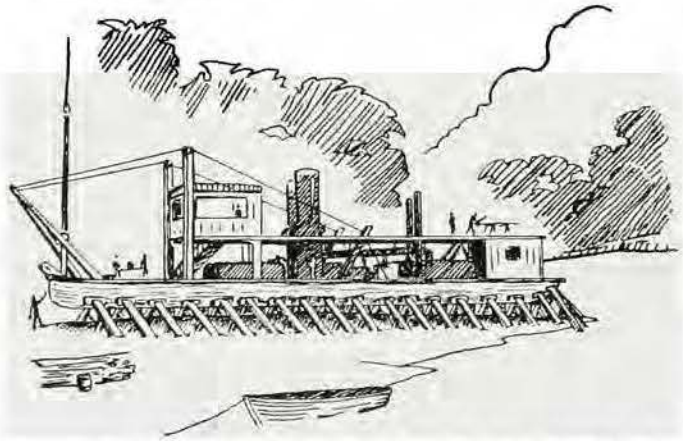
Waters which receded after portions of raft were cleared left many cypress swamps

Jefferson mushroomed. By 1869 she boasted a population of 11,000 people, and her merchants received goods valued at $20 million annually. When the raft was cleared, the waters receded from Cypress Bayou. By 1877 the city had shrunk also—to 5000 souls, and her merchants conducted a trade that amounted to less than $2.5 million that year.

The decline of this once-booming commercial center was blamed primarily on two factors, and the assistance of the Corps was sought in the town's efforts to remedy both problems. The removal of the raft was the most popular scapegoat. Floodwater that once had filled the slackwater route between Shreveport and Jefferson now flowed freely downstream. Commercial boats found it increasingly difficult to deliver goods to Jefferson, and much of their business was being given to the new Texas and Pacific Railroad that passed through that city on its way to more interior parts of Texas. To worsen matters, as water competition decreased, the rail rates increased—to the point that the area residents claimed they could no longer afford to use the rails. If the Corps would assist them in reviving navigation into their city, the railroad fees would have to drop to a more competitive rate.

The first complaints made by the citizens of Jefferson to the Corps of Engineers occurred while the region was still under the charge of the New Orleans Office. The supervising engineer there felt that the complaints were just and recommended that slackwater navigation to that city be maintained by the dredging of Cypress Bayou and the erection of a dam at the foot of the bayou. But Congress failed to appropriate sufficient funds for the work.

The citizens of Jefferson then offered to lend the Corps a dredge boat purchased 3 years earlier as part of a $70,000 community project to alleviate their navigational problems. The Corps accepted the loan and used the dredge to effect whatever improvements were possible. As the New Orleans Engineers had foreseen, however, dredging alone did not accomplish the desired results.



Water commerce continued to decline at Jefferson, and rail services increased. Under the circumstances, the Engineer Office at New Orleans began to question the value of the suggested improvements. Upon the transferral of the area to the authority of Vicksburg's Captain Benyaurd in 1874, Benyaurd conscientiously reported the pros and cons of the sought-after project to his superiors and left the ultimate evaluation of the project's urgency to Congress. Throughout the decade that followed, that body appropriated only a minimum of funds, hardly enough to maintain adequate dredging and snagging operations.

The Jefferson dredge sank in the winter of 1875-1876 while in use by the Corps, its loss a severe blow. Without this vessel, Benyaurd had no hope of continuing any activities on Cypress Bayou. As soon as conditions permitted, the machinery was salvaged from the sunken dredge. There in the Texas woods, in the hottest part of summer, with no shipyard available, two civilian employees of the Corps, Joseph Burney and M. B. Lydon, directed the construction of a new dredge, utilizing as much of the sunken boat as possible. Their ingenuity, determination, and craftsmanship earned for them Benyaurd's highest commendation.

Water commerce into east Texas continued to decline. The citizens continued to complain. A resurvey and examination of the area was later authorized in 1884 to reassess the feasibility of such improvements as locks and dams, and it was again deemed inadvisable. Throughout the Nation, waterborne commerce was yielding to the superior services of the railroads, and the Federal government did not feel that it was financially able or constitutionally empowered to subsidize navigational interests in their competition with other modes of transportation.

Much of the Corps activities, even in this early period, hinged on a balance of values. Requests were made from all quarters for

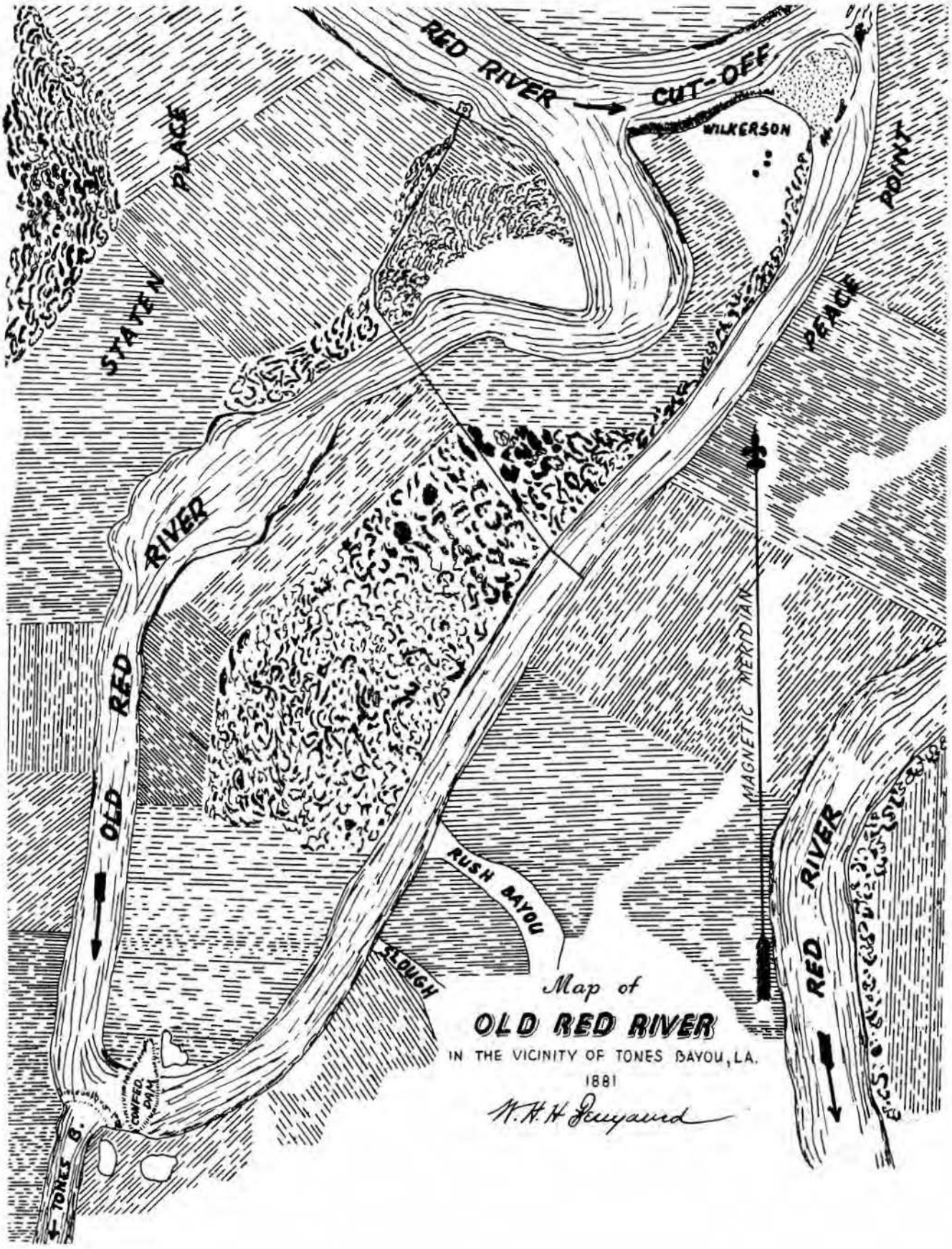
improvement or alteration of the most minute streams. Diverse interests within the economy had different, and often conflicting, needs and desires. Determination of the feasibility of proposed projects, and the priority of each, demanded an impartial assessment that coldly weighed cost versus benefit. Funds, always limited, had to be dispensed in a manner that would produce the greatest service to the largest number of people at the smallest cost.

While the Corps, even with the help of Congress, was unable to rescue Jefferson from economic distress, measures were taken to relieve her sister city, Shreveport, from a similar fate. About 1850, 19 miles below Shreveport, a riparian planter had cut a drain between Red River and Bayou Pierre. Over the years, the drain had grown to sizable proportions. By the 1870's it had assumed the name of Tone's Bayou and, at high water, was drawing off 75 percent of the flow from Red River. These waters were channelled, then, down Bayou Pierre to that bayou's juncture with the Red, just above the town of Grand Ecore in Natchitoches Parish. During low water, the stretch of Red River between the mouth of Tone's Bayou and Grand Ecore was barely navigable.

The continued enlargement of Tone's Bayou brought fears that the entire Red River would be diverted through the bayou. Trade between Red River planters and the commercial center of Shreveport would be impossible from July to January, the 6 months of each year when the farmers shipped their crops. Although such a change would enable Tone's Bayou planters to ship their goods more conveniently, the commercial interests at Shreveport were not content with the thought of the exchange, since Red River was far more thickly settled. By 1875 Shreveport citizens had organized a Board of Trade with hopes that these representatives could persuade the government to close Tone's Bayou and divert the threatened disaster.

The Corps received congressional authorization to proceed with the bayou's closure in 1876. Initial attempts to carry out the project were ineffective. Low-water dams of piling were beaten apart by driftwood; eroding banks contributed to their destruction. A brush mattress dam was then attempted, but high water and severe weather posed new problems. On the day after Christmas 1876, for example, the crews were at their posts but could not work because the brush with which they worked was buried under snow that had accompanied "one of the coldest and severest storms...that ever visited this portion of the country."

Stones were needed as weights to sink the brush mattresses, but they were unavailable in the area. Sandbags were substituted, but they were prone to rot. The sandy soil on which the dam had to be erected provided a poor foundation. Only by using 350 sandbags per mattress were the Engineers able to steady the foundations of the dam. Earthwork was built up to 5 feet above water level. Several heavily laden buggies and wagons crossed it safely before melting snow created a rush of water pressure which caved the dam in several places. The earthwork was beyond repair, but the mattresses did not budge. No funds remained for the dam's repair. Advised of the situation, Captain Benyaurd made a personal inspection and suggested that wing dams be extended from the remaining structure for


RED RIVER
CUT-OFF
WILKERSON
POINT
PEACH
STATION
PLACE
OLD RED RIVER
MAGNETIC MERIDIAN
RED RIVER
RUSH BAYOU
SLOUGH
TONES B.
CONFED. CHIM.
Map of
OLD RED RIVER
IN THE VICINITY OF TONES BAYOU, LA.
1881
W. H. H. Tunyard

utilization as a low-water dam. Interested citizens from New Orleans to Shreveport raised $3000 to help fund the work, and the dam was rebuilt successfully.

The completion of the low-water dam at the mouth of Tone's Bayou was but a stopgap measure. Benyaurd repeatedly requested additional funds to raise the dam to a high-water level that would be adequate under most circumstances. His requests were not granted until 1878, and the low-water dam had already been damaged by driftwood which passed over it in high-water stages. Repairs were made and work proceeded on the dam until high water forced suspension of the work in December.

Although the closure of Tone's Bayou was of considerable import to the Shreveport area, the families along the bayou itself were keenly opppsed to the work. Many of them felt their plantations would be damaged by floodwaters if the bayou were closed. Many others openly stated that they hoped the Tone's Bayou-Bayou Pierre route would be taken over by the Red, since the value of their plantations would increase as a result of being situated along the main steamboat channel. Assistant engineer Joseph Burney, in charge of the project, reported "open hostility" shown to him by citizens in the neighborhood. "I have always found them generous, hospitable, and law-abiding," Burney informed his superiors, "but in this case they hold the Government has no right, without paying damages, to injure their property for the benefit of others, and they consider they have a legitimate right to destroy the works."

Destruction of the works was exactly the defense employed by certain residents of the area. In 1864 the Confederate government had erected a dam that was now in close proximity to the works that were being built by the United States Engineers in the Tone's Bayou area. The Confederate dam had stood for 19 years, and natural deposits had strengthened it. Yet, on the night of 1 December 1881, it gave away. The sweeping waters that rushed through it caused a loss of pressure behind the new earthen dam built by the Corps and destroyed the Federal work.

Benyaurd immediately suspected sabotage. Only a week before, he had personally inspected the old dam and found it in sound condition. Two months later, his suspicions were confirmed. A group of masked men surprised the civil contractor whom the Corps had employed to erect the remaining dam and overpowered the contractor and his laborers. When the trespassers cut a ditch across the dam, the water that rushed through the gap washed away the entire structure.

The responsible parties were never apprehended, and their illegal actions accomplished the desired results.

The futility of building such structures against such vociferous local opposition was obvious. Leading Shreveport citizens, despite their personal desire to see the completion of the work, openly admitted defeat. N. C. Blanchard, a Shreveport legislator, editorialized in that city's newspaper: "The question can only be...settled by thoroughly competent engineers.... This much we can safely say, however, if the government should build a dam across Old River at the head of Tone's bayou...it would be under the necessity of keeping an armed force constantly on the

ground." The Vicksburg Engineers had no choice but to abandon the project. Ultimately, the bayou filled with drift and silt, gradually closing. The stretch of Red River below the mouth of Tone's Bayou scoured, widened, and confined itself to the main channel.

Elsewhere on the Red River, navigation improvement works continued with much less opposition. Since the advent of man upon that river, the rapids at Alexandria had been a particularly vexatious obstruction. National attention was focused upon the area as a result of the Red River Campaign of 1864, but it was to be a decade before Congress appropriated funds for a survey to determine the best means of correcting this natural hazard.

The survey of September 1874 and the resurvey of 1878 called for excavation of a channel 75 feet wide with a permanent depth at the upper falls of 4.5 feet below the low water of 1874. The lower falls could best be countered, it was believed, with a dam built of the rocks removed from the upper falls. The project was authorized, bids were let, and the contract for the work was awarded to a New Orleans firm which undercut its only competitor by 300 percent.

The work of the contractor fell far short of expectations. His inexperience was as obvious as the insufficiency of his plant. Then factors beyond the contractor's control retarded the progress. High water occasionally halted all work. Alexandria experienced a malarial epidemic, and the contractor himself was seriously ill. Hired labor became scarce, since they all "knew" that "a few days work on and in the water, under the hot sun, had the effect to bring on fever."

Numerous extensions of the work were requested and granted between 1882 and 1885. By the time that the Corps terminated his contract in November 1885, the contractor's work was almost—but not quite—complete. It was anticipated that additional work would be needed as soon as funds became available. However, in the interim, steamboats proceeded to navigate the falls with little or no difficulty.

HARBORS AND FLOODWALLS

A contiguous project of vital interest to the Alexandria region was the protection of that city's caving riverbank. The old Bailey's Dam, a constant reminder to area residents of the

past military occupation of their city, was also the agent of destructive currents. Surveys of the riverfront in 1878 and 1883 indicated that "upwards of 50 feet" had caved into the river during that 5-year period. While the Corps anticipated some alleviation of the condition from their work on the falls, they also felt that the only permanent protection lay in the stabilization of the banks. A project was submitted and approved in 1884.

A series of problems arose from the initiation of the project. As originally designed, the bank would be graded to a slope of 2.5 horizontal to 1 vertical, and a certain amount of private land would have been destroyed, although the loss would not have been greater than that which would have resulted eventually if the river was left to its own actions. The residents affected refused to relinquish their land without payment, and the congressional allotment did not allow for this contingency. An alternate but equally effective plan had to be devised.

In the course of preparatory surveying and planning, the assistant engineer in charge of Red River projects in that area, J. W. Beaman, was arrested by the district attorney. A New Orleans steamship line, misunderstanding the nature of the improvements at Alexandria, complained that the Engineers were threatening the river's navigability. Beaman's bond was posted by an appreciative local resident, but the legal embroilment continued for a full year before the charges were dismissed by a new district attorney.

In submitting his report for that year, the beleaguered engineer expressed his gratitude to "all the officers of the court [who] have been most courteous while carrying out the necessary proceedings under the ill-advised

Bank caving on the Mississippi threatens nearby tenant house

Natchez "Under the Hill"

action" and offered his sincere appreciation for "the energy and loyalty of all those connected with the works...under my charge; foremen and laborers alike deserve credit for their efficiency and industry."

Throughout the formative years of the Vicksburg District, harbor protection was a frequently encountered demand. At Greenville, Mississippi, citizens warned that caving banks would soon destroy navigation by the "correspondingly rapid formation and growth of the already extensive sand bar" on the Arkansas side of the river.

Residents of Trenton, Louisiana, similarly complained of caving banks. However, the little settlement of 800 inhabitants lacked adequate commerce to justify the expenditures that would have been involved. The nearby town of Monroe sought bank work also. Again, an extensive survey of prevailing conditions was made. The results indicated that the caving was currently miniscule and that the small amount of businesses or personal property which faced any serious threat could be easily protected with small expenditures by the owners.

The twin harbors of Natchez and Vidalia faced a more critical threat. A series of bends snaked the Mississippi's approach to these two towns, and the turbulent river threatened to shorten its path by cutting through the neck of each bend. Left to its own course, the river would have destroyed the approaches to

City waterfront at Vicksburg bustling with rail and water commerce

Natchez and Vidalia and the two cities would have been stranded without a river.

Benyaurd ordered a survey of the threatened bends in 1879, and the cost of the necessary protective work was estimated at $939,600. Congress responded with an appropriation of $40,000. The sum was too small to provide for any significant work at the endangered points, and the river broke through the middle bend, into Lake Concordia, within a matter of months. Then, with the subsequent formation of the Mississippi River Commission, the Vicksburg Engineers were relieved of future work on these Mississippi River ports.

Of the river towns in the District that sought Federal assistance during this period for the maintenance of their harbor facilities, Vicksburg itself faced the most serious threat. It also suffered the most serious consequences when preventive work was not authorized. As early as 1870 a group of "first citizens" of Vicksburg contacted the Office of Western Rivers Improvement, then at Cincinnati, and expressed fear that the Mississippi would change its course and leave their harbor stranded. Two cutoffs, at Terrapin Neck and Davis Bend, had occurred already. A third cutoff was threatening.

Colonel J. M. Macomb of the Engineer Corps personally visited the city in the spring of that year and examined the crucial bend, Delta Point, which lay opposite the city of Vicksburg. Macomb reported a rapid washing away of the shore. In fact, the steamer that conveyed him to that spot churned through deep water in an area that had been behind levees and under cultivation a few years earlier. Convinced of the necessity of preventive work, Macomb recommended that a preparatory survey be conducted before the year was out.

The suggested survey was conducted on schedule. Both the surveying engineer and the Office of Western Rivers Improvement were impressed with the urgency of Vicksburg's needs. "Apprehensions...are only too well founded," Colonel W. F. Raynolds reported; "the necessity for prompt, energetic action to prevent such a calamity is manifest." Captain Charles Suter, in charge of the survey, reported that Vicksburg possessed "the most

commanding site and the finest harbor on the Mississippi River." Vicksburg's importance from a military point of view was unsurpassed. "It is a perfect Gibraltar against an attack either by land or water, and may truly be said to be the key of the Mississippi Valley." If the river were permitted to change its course and bypass Vicksburg, the Nation would lose this key position of defense. Moreover, the town was experiencing considerable economic growth; the value of its taxable property already exceeded $7 million. Without a harbor, the economy would stagnate.

Suter's survey graphically exposed the impending catastrophe:

> *The borings executed under my directions gave most disheartening results.... The whole extent of the upper side of the peninsula presents nothing to resist the action of the river but unstable layers of sand of great thickness, which are already permeated by the river water to a distance of at least 500 feet from the river itself, and probably much further.... The cutting action of the river merely washes out this loose sand...and precipitates considerable portions of the bank into the river.*

The preventive measures recommended by Suter were estimated to cost $2.7 million, using locally available stone. "It would be highly important to have the whole sum necessary appropriated at once," the engineer urged. "If the present rate of abrasion should continue for a year or two longer, it would be too late."

In spite of the dire predictions of the Army Engineers, Congress failed to appropriate the funds. The river continued to wash at Delta Point below Vicksburg, and at Vicksburg Bend above the city. Finally, at two p.m., 26 April 1876, on the eve of the Nation's centennial celebrations, the Mississippi cut through the neck of the bend entirely. One of America's key defense ports was left without a river. Vicksburg's formidable bluff now overlooked a mere lake, dubbed Lake Centennial. The river now bypassed the town at some distance to the west.

The Centennial Cutoff at Vicksburg created a curious situation, but one typical of conditions at a number of points along this river. The original boundary line between the States of Mississippi and Louisiana were set in the middle of the Mississippi River. That point of land that lay within Vicksburg Bend also lay on the Louisiana side of the river. Now it was an island, called DeSoto, and rested in the midst of Lake Centennial on the Mississippi side of the river. For the century since, this small tongue of land above Vicksburg, lying wholly within the boundaries of Mississippi, has remained the property of the State of Louisiana.

Vicksburg's plight was serious after this cutoff, and it threatened to become even more so. The continued wearing away of the banks at Delta Point promised to lure the river even further from the strategic city. Temporarily, Vicksburg still had access to the Mississippi through Lake Centennial, but the ends of this oxbow lake were rapidly silting. It was only a matter of time before the city would be completely stranded. The treacherous Mississippi was accomplishing on its own the very deed it had refused to do for Grant's engineers 13 years earlier.

Vicksburg appealed again to the Federal government to alleviate its distress. The Engineer Department formed a special board

National Cemetery at Vicksburg. Old bed of Mississippi River (now Yazoo Diversion Canal) is in background

to study the situation the following year. The committee was cognizant of the city's imminent danger; they noted that the banks at Delta Point were caving as rapidly as 300 feet a month during flood stages. But its members were unable to make any constructive recommendations without more adequate information. Apprised of the need, a citizen's committee from the city employed one of the most qualified civil engineers available, Thomas G. Dabney, to make the necessary surveys and examinations.

Dabney's report was prompt, thorough, and blunt. Soundings were taken in the Mississippi itself, in Old River, at the Vicksburg harbor, and in all the area lakes and bayous. His report included extensive maps and cross sections. It also reiterated Vicksburg's commercial importance and its dependency on the Mississippi water route (83 percent of the cotton shipped out of that city, not to mention merchandise taken in, were conveyed by way of the Mississippi). Dabney also plucked a tender heartstring of the Nation in pointing out that water access to the national cemetery was being cut off:

> *It should be a matter of great pride to preserve to it the position originally designed in the selection of its location, overlooking the great national highway of commerce, which washes its outer wall with the waters collected from three-fourths of the Union, possibly bearing mementoes from every homestead of the poor fellows who lie there in eternal sleep where they fell in the service of their country.*

Congress was touched. Its appropriation of June 18, 1878, provided $84,000—the full amount which the Board of Engineers had requested for the completion of the first stage of the project. As designed by the Board, the plans called for four separate works. The most immediate concern was the stabilization of Delta Point to prevent further recession of the river from Vicksburg. Second, a bar dike was needed to cut the eddy current which was filling the Vicksburg harbor with mud. As designed, this dike would be an extension of DeSoto Island that would cause the upper (west) end of Lake Centennial to silt up completely. Third, it was recommended that the harbor, especially the entrance through the lower (east) end, be kept open by dredging. The final suggestion was the diversion of the Yazoo River into the newly formed Lake Centennial at a point in front of Vicksburg.

The stabilization of Delta Point proved to be a challenging and vexatious affair. The insolent river thwarted the work of the engineers in every way possible. Its unexpected rise destroyed much of the initial work. As her swamps and bayous swelled, they nurtured a potent generation of *Aëdes aegypti*, that murderous species of mosquito which winged the "yellow jack" throughout the lower Delta. Local authorities, suspicious of sanitary

Vicksburg's First National Bank Building housed the Engineer offices prior to World War I

measures observed by the transient laborers, forced the closure of the project in August 1879.

As work resumed in November, the obdurate river allied with the arctic winds and deluged the work site with a rare avalanche of running ice. The weather had scarcely warmed before the river's crest brought a flood of driftwood that posed another serious obstacle. Late August 1880 again saw the suspension of the work as yellow fever reappeared and the health boards of Vicksburg, Mississippi, and Delta, Louisiana, bickered over the possibility that the workers might transmit the disease from one community to the other. The ingenuity and obduracy of the Engineers as they battled these adversities were commendable. By 1882, when the project was transferred to the authority of the Mississippi River Commission, the Vicksburg Engineers had successfully protected 4800 linear feet of bank below the low water level.

The stabilization of Delta Point did not cure all of Vicksburg's ills. As Congress slowly doled out appropriations for the remaining three stages of the work on that harbor, economic activity in the area continued to decline. Businessmen were afraid to build facilities near the water since the shifting river made it impossible to select a permanent site. The St. Louis and Vicksburg Anchor Line, the most important steamboat line on the Mississippi, had a large elevator in operation at Vicksburg, but its usefulness rapidly decreased in correlation with increased shoaling of the harbor. Ultimately the elevator ceased operations. Business on the Vicksburg and Meridian Railroad dropped off, since much of its track within the city was useless during parts of the year, and relocation of the track and docks was a particularly uncertain gamble.

Similarly, the Vicksburg, Shreveport, and Texas Railroad curtailed its activities in the Vicksburg area. The lines at that time were already connected to eastern rails that reached

Dredge prepares old riverbed for waters of the Yazoo

the Atlantic, but they extended westward across the Mississippi only as far as Monroe. Plans called for the extension of the line to Shreveport, where it would connect with the Texas railroad system and, "at an early day extend west to the Pacific." It would, then, provide Vicksburg with its long anticipated status as the terminal of a transcontinental railroad. However, engineers of the VS&T Railroad feared that the instability of the river at Vicksburg would make that city an undesirable terminal.

As various businesses became concerned over their interests in Vicksburg, the city faced a sharp decline in prosperity. Not until the Mississippi River Commission successfully completed the Yazoo River diversion canal, and thereby guaranteed Vicksburg a reasonably permanent access to the Mississippi River, did the economy of that city fully recover.

A SCORE OF SECONDARY STREAMS

Throughout the formative years of the Vicksburg District, her Engineers were not only at work upon the major tributaries, but also were called upon to investigate the feasibility of improving navigation upon a host of smaller rivers, creeks, and bayous. Their surveys and examinations in the back country of Mississippi, Louisiana, and Arkansas spotlighted several waterways whose improvements would spark economic development of the region. On the other hand, the Engineers also sounded the death knell for a number of minor streams whose deterioration had progressed to the point that improvement could never be justified under a cost-benefit ratio.

At one end of this range of extremities lay the Big Sunflower of Mississippi. Rising out of Mud Lake in Coahoma County, it flowed southward into the Yazoo River. The lands along its banks were deemed the "richest cotton producing portion of the State of Mississippi, yielding with moderate cultivation a bale of cotton to the acre." Vast quantities of timber were rafted from it annually. Millions of staves were made along its banks and boated to New Orleans.

Still, at the time the stream first was surveyed by Corps Engineers in 1879, it was navigable only 6 months of each year, and then only by light-draught boats. There were no artificial obstructions in the river, bridges or dams. The only interferences with navigation were the natural shoals, sandbars, and snags. The value of the freight being shipped from the region, such as cotton, lumber, and plantation supplies, was estimated at $2 million. Yet, the unreliability of water commerce along this stream forced a number of the planters to haul their harvests overland to the Mississippi at great effort and expense. With improvement of the Sunflower, it was anticipated that the value of the freights shipped upon it would double.

Over the next 15 years, work was conducted on this stream by the Vicksburg Engineers as regularly as funds permitted, appropriations for its improvement being made in 9 of those years. In addition to routine snagging and clearing work, ten wing dams were immediately built at one of the most

dangerous obstructions, Oliphant's Bar. They were small but effective. The first, for example, was 132 feet in length and constructed of sixteen 4- by 4-inch piles driven at depths of from 8 to 10 feet in the mud. The tops of the piles were joined with a side stringer of 2- by 12-foot plank, secured by 60-penny nails, and vertical sheeting of 2-inch plank fortified the pile walls.

The dams proved their value almost immediately. In the first low-water season, a series of packetboats that normally were detained on the bar for 3 to 4 days passed through its entire length with no difficulty. At the close of the season, the civil engineer in charge of the work reported to Benyaurd the "manifest appreciation on the part of the rivermen and planters along the Sunflower of the good you have done them within the limited time of your operations."

Throughout the length of the river, a variety of improvement measures were initiated. Shoals of mussel shells and clay were loosened with explosives at Dead Man's Bend, and some 164 cubic yards of lumps were excavated. The resulting increase in velocity of the currents scoured a channel 3 feet deep where there had been but 6 inches before. Lumber and logs were removed from the channel, also with explosives. Leaning timber was cleared, often by girdling the trees until they died and fell into the river. As dry timber, they would float away without damage to the waterway, whereas green timber sank and established itself as snags.

Improvement of the Sunflower accomplished the results that the Vicksburg Engineers had predicted. Insurance rates for local residents and businessmen were lowered from 20 to 25 percent. Freight rates decreased even more. Settlements sprang up all along the river's banks, "Plantations being cleared...where a few years before it was a wilderness." The value of the river's improvements was manifold in comparison with the $62,000 spent on improvement of the waterway in this period.

At the other end of the extremity, there were waterways that once had bragged considerable importance, but changing conditions prompted the Engineers to conclude that improvement now would be of little benefit. The Cane River of Louisiana had once been the channel of the Red River itself. It, too, ran through a region that contemporaries had described as "the most productive cotton-growing land in the state." The average yield there was also one bale to the acre. Its valley boasted one of the thickest settlements in the state, and one of the oldest.

In the 1830's, however, the Red River changed its course. A stretch of waterway some 50 miles in length was abandoned in

favor of a small rivulet to the east. The old river bed was renamed the Cane. By 1884 its deeply chiseled banks were dry for nearly 6 months of the year. Planters found it necessary to haul their cotton and other products over to the Red, a distance of from 4 to 8 miles. The amount of this produce equalled that produced by the planters in the other Red River parishes combined.

In 1882 the Vicksburg Engineers surveyed the river, and Major Alexander Miller concluded that the stream was not worthy of improvement, nor was the work a public necessity. Congress made a subsequent appropriation of insignificant size toward the removal of obstructions, and the Cane was dropped from the Engineers' list of navigable streams.

In 1890 a second examination was ordered with a view toward improving the Cane with locks and dams to afford year-round navigation. Again, the District Engineer, Captain J. L. Willard, concluded that it was not worthy of improvement. The river was "made up of pools, bayous, and swamps," he reported, and these were "interrupted by deposits considerably higher than the average stage of the main river. The bars have risen above the low-water line of Red River to a height that Cane River cannot be entered from above except at flood stages."

It was Willard's general opinion that locks and dams would be of almost no benefit. Steamboating on the river would be profitable only if the channel was navigable during the harvest season. However, this season was also the same period in which the water reached so low a level in Red River that navigation had to be suspended in the main channel. Without

Joseph L. Willard

year-round access to the Cane through the Red, there was little need to improve the Cane itself.

For these reasons, Willard recommended in 1890 that the Cane be treated as an injurious outlet. Its upper end, which was gradually filling up on its own, should be "permanently closed by a dam and levee to confine the floodwaters to the main river." Decades would pass while the pros and cons of the issue were bandied about between private, economic, and political sectors; but, ultimately, Willard's recommendation would be implemented.

Between these two extremes there existed a variety of situations which demanded impartial assessments and skilled value-judgements by the Army Engineers. Streams, such as Louisiana's Bayou D'Arbonne and Bayou Bartholomew, were considered worthy of improvements from a commercial standpoint, and the Corps was authorized, initially, to proceed with the removal of obstructions: wrecks, fish traps, and cyclone debris, as well as snags and overhanging timber. Yet, as it became increasingly obvious

that the work would never be permanant and continuous maintenance was necessary, Congress reduced its already meager appropriations.

The zeal which the Army Engineers and their civilian employees showed in their efforts to improve these minor streams with insufficient funding was often surprising. Invariably, water levels permitted work only in certain seasons; during those seasons, every effort possible was made to utilize each day to the fullest. The Bayou Bartholomew crew did not work on Christmas Day 1881 only because the water rose suddenly to an inoperable stage. At the end of that working season, the equipment was left in the care of a local resident. When overseer R. M. Spicer returned to the bayou with his crew the following year, it was learned that their flatboat had sunk. Spicer raised the boat and found that it was very leaky, but still serviceable. "I had no trouble with the boat during the season," Spicer later reported, "only she had to be pumped out every night."

Walker Davis, the assistant engineer in charge of improving Tchula Lake in Mississippi, faced a similar difficulty. Arriving at his work site in 1882 he learned that his new flatboat, built only the year before, had disappeared completely during that season's high water. Wilson procured an old ferry boat, only 9 by 28 feet, built a deck that projected 1.5 feet over each gunwale, and thereby made floor space of 12 by 28 feet. Building a small shed for the kitchen at one end, he pitched his own tent at the other and set up a supply tent in the middle. Oar-locks were attached to the front of the barge, generous-sized oars were cut from area timber, and the crew was reequipped for that season's work with only a minimum of lost time.

In other situations, the commercial need for channel improvement was obvious, but the nature of the existing obstructions demanded so large an appropriation that the work was not deemed feasible. The North and South Forked Deer Rivers of Mississippi and Tennessee, for example, were intersected by a series of county and railroad bridges, brush dams, and log booms. Three separate surveys of these rivers were authorized by Congress as local residents continued to seek help in the two decades between 1874 and 1894. All of them agreed that the cost of removing the obstructions could not be justified.

The existence of railroad and county-owned bridges and other man-made obstructions were frequently the cause of a stream's demise. Private citizens along Bear Creek in Mississippi attempted to clear a channel, ignoring the natural channel of the stream—and then permitted the green logs to fall into the water. The creek was soon

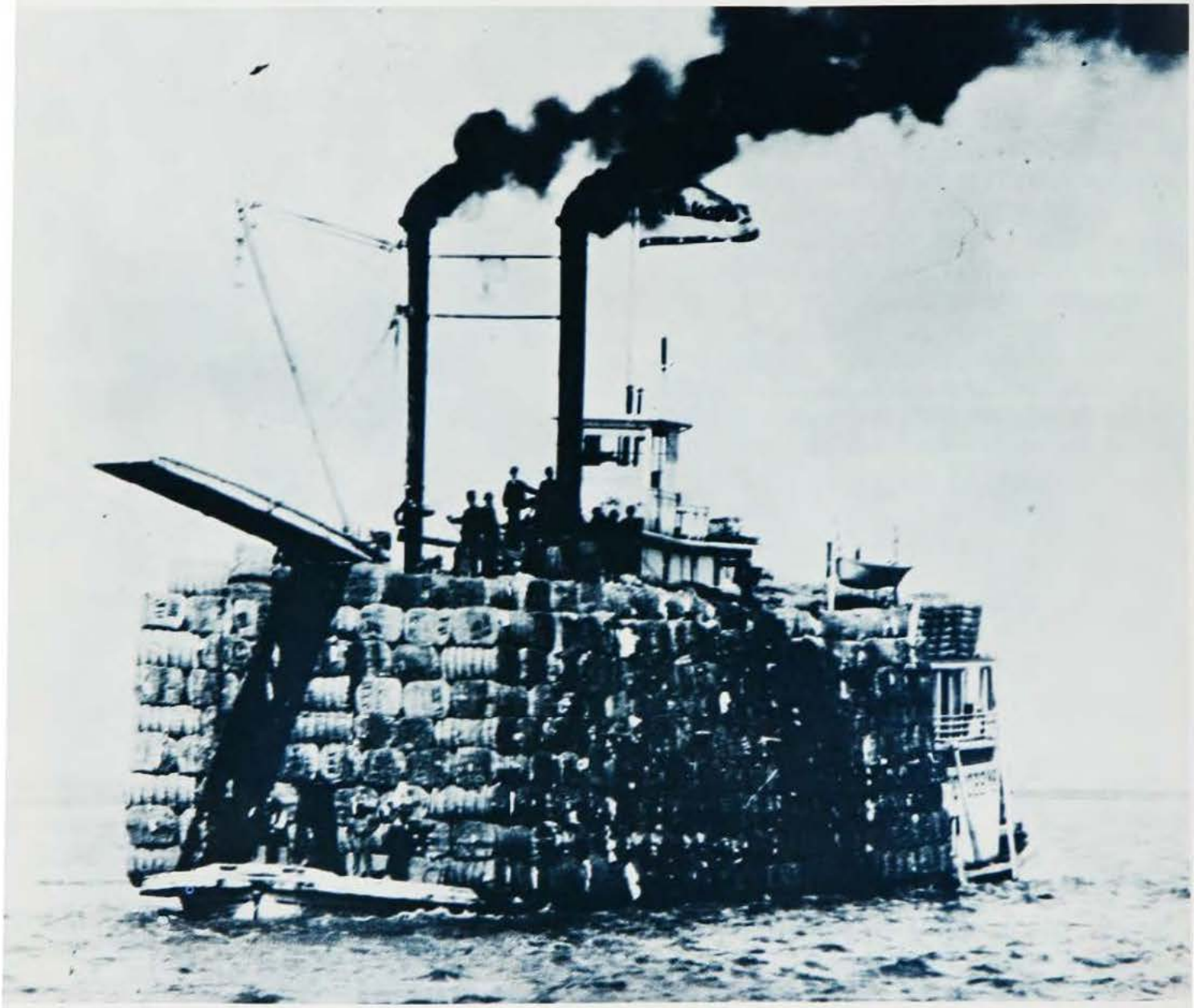
hopelessly clogged. On Mississippi's Big Black, overall conditions were considered conducive to the improvement of the river, but the existence of four low bridges, two railroad and two highway, prohibited navigation of the channel. State laws were passed that required the removal of low bridges and prohibited the future construction of any, but the resulting litigation stretched over a number of years. The Corps was helpless, in the meantime, to make the river navigable, and commerce gradually declined to the point that it apparently would never revive.

Many of the smaller streams within the early limits of the Vicksburg District required only minor improvements to render them navigable for years to come. In a number of cases, one lump appropriation of sufficient size would have satisfactorily completed the project—yet the congressional policy of providing only a portion of funds required resulted in the needless continuation of the project for a number of years, with little satisfaction being given to anyone. On the Big Hatchie River of Tennessee, for example, Captain Willard noted in seven consecutive annual reports:

> *As the stream is over 300 miles above Vicksburg (the office of this district) it is difficult to supervise the work, and expenses of administration are considerable. Economy would be subserved by expending sufficient...in one season to put the river in so good a state as not to require work for several years. It costs no more to get ready for six months' work than for six weeks, and the expenses of administration are practically the same for both periods.*

Congress never saw fit to accede to Willard's request.

By 1888 the United States Army Corps of Engineers was recognized as an indispensable force in the midvalley area. Navigational interests deemed her services invaluable. All sectors of private enterprise courted her attentions; even those that disagreed with her policies felt it necessary to sway or coerce the Engineers to their own position. Within Vicksburg itself, the Engineers were accepted as the city's financial savior, a staunch supporter who upheld her interests against a tight-fisted Nation. The town of Vicksburg had begun already to think of herself as "The Engineer City."



Chapter III
AN ERA OF TRANSITION

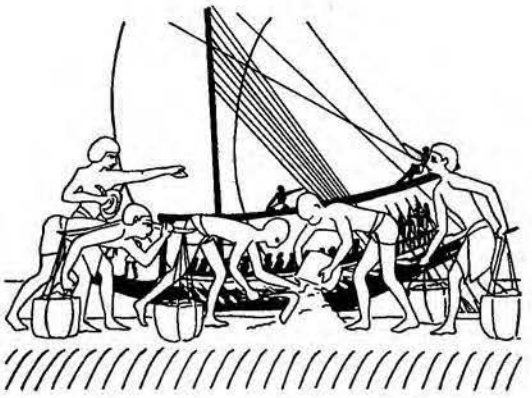
Let me but do my work from day to day,...
Let me but find it in my heart to say,...
"This is my work; my blessing, not my doom;
Of all who live, I am the one by whom
This work can best be done, in the right way."

Henry Van Dyke

As the nineteenth century hastened to its end, the United States took a new deep breath and plunged into the Age of Technology. Her treasury bulged with an annual surplus of $100 million. Her populace chorused a demand that the funds be used for internal river improvements. The minds of her best scientists, engineers, and scholars churned with new ideas, concepts, and approaches to the application of science. It was to be an era in which America's Corps of Engineers would revolutionize countless facets of hydraulic engineering, and the engineers of the Vicksburg District were to hold their own in the technological development of the Nation.

It was also an era in which the public conscience began to accept—but not so rapidly—a new dimension of social thought. America's sociologists demanded a new concern for the working conditions of the masses at the bottom rung of society. Again, the Vicksburg Engineers pioneered the movement within their region, setting examples of employer-responsibility that would, eventually, become the accepted pattern. It was an age in which the American public would come to accept its responsibility for the safety of all Americans and make new demands upon the restructured Corps of Engineers for assistance in a broader range of activities.

Vicksburg during the first decade of the twentieth century. Note the high water on the riverfront buildings

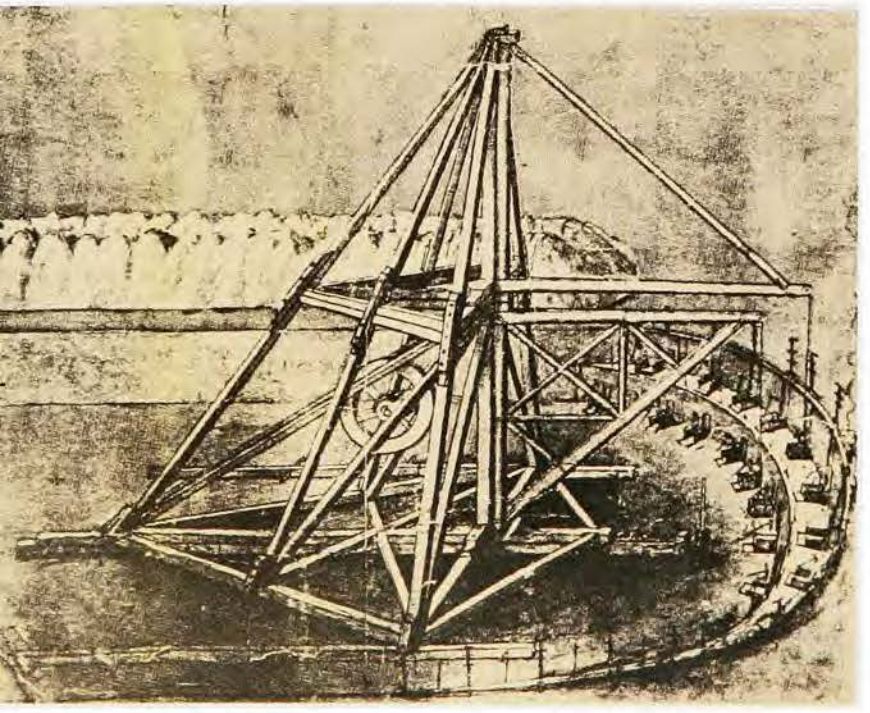


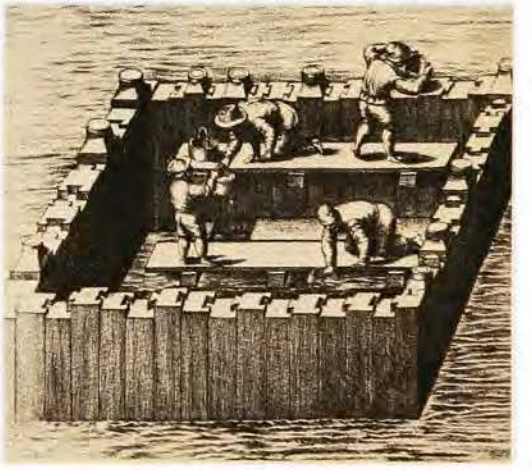
EQUIPMENT

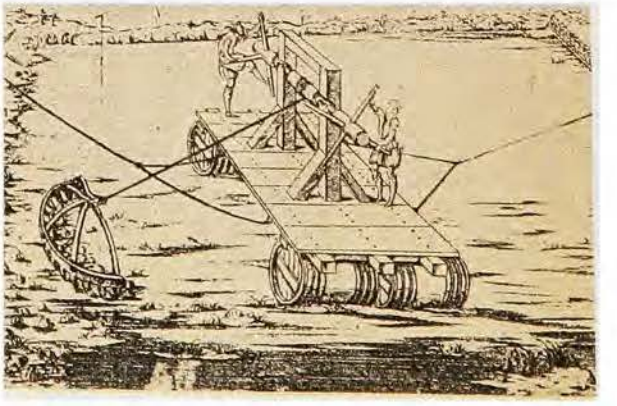
Over four millenniums, the basic principles of hydrographic engineering had changed little in many respects. In ancient Egypt and Babylonia, channels were dug and levees built with human labor, simple handtools, and animal power. Early levees and channels in the lower valley of the Mississippi were formed in much the same manner. Black slaves and Irish immigrants bent their backs over shovels and wheelbarrows. In still later development, mule-drawn scrapers packed each layer of built-up earth.

Sixteenth century Europe saw the development of a crude machine for dredge work, a clamshell device operated by a hand winch. As late as the nineteenth century, hand dredging was still the most effective and dependable means of excavating dirt. With the development of steam-powered watercraft, mechanical dredges became more practical, and by 1850 primitive steam dredges were being seen on many of the eastern waterways. Within the Vicksburg District, the first dredge boat was built in 1878, "a powerful shovel dredge boat, fitted up with every convenience and capable of excavating 750 cubic yards per day."

(left) Drawing by Leonardo da Vinci of dredge for canal building. (upper right) Dredging by hand, using a cofferdam, circa 1588. (lower right) Dredge of late sixteenth century.







U. S. Dredge GAMMA *working to restore the new channel in the Yazoo River in front of Vicksburg*

This early emphasis upon superior equipment within the Vicksburg District set the pattern for the development of its physical plant. By the late 1800's, America's machine companies and ironworks vied for the honor of producing the most efficient dredging equipment in the world, and Vicksburg's Engineers carefully studied all the latest developments—herculean dredges and pumping machines, centrifugal, vacuum, and undulating. Their best machinist visited Milwaukee, Dubuque, and even the Chicago World Fair Exhibition in 1893, on his own time, in search of the best equipment the District could afford.

By 1895 the District boasted a dredge far superior to the one built proudly in 1878. The new vessel was equipped with an endless chain machine and a 90-foot steel-frame conveyor for spoils. Its heavy rubber belt operated at a speed of 300 to 400 feet per minute. Three sets of double engines, with condensor, pumps, and extraduplex bilges, with ducts and fire pumps, two steam spud hoists, a rear-walking spud, freshwater tanks, coal bunkers, and cabin quarters made it the most efficient machine boat yet acquired by the District. Operating at maximum capacity, the new dredge removed an unbelievable quantity of 500 cubic yards per hour. Subsequent models would soon outdate even this equipment, as such refinements as condensing engines, electric lights, refrigerating plants, orange-peel buckets, and pipelines were added.

Indeed, much emphasis was placed in this period upon the development of a modern and efficient plant. The District's equipment was revolutionized, replaced, and expanded as changing conditions and new technology rendered the old plant obsolete. Firewood for steam power, for example, became increasingly hard to obtain as the Engineers continued their work of clearing the rivers of snags and the banks of caving timber. Coal became the standard fuel, with great benefits in speed and productivity. An inspection boat could now run at 10 to 12 miles per hour in still water. Yet, the new equipment consumed such immense quantities of the fuel (as much as 225 pounds of coal per hour) that it soon became difficult to obtain sufficient quantities of this natural resource as well.

Gasoline-powered equipment was introduced into the District in 1899. Boring machinery, outfitted with a six-horsepower gasoline engine, was erected on a catamaran for use on the Ouachita and Black Rivers. By

New steel barge for use in channel improvement

1903 the District's inspection boat was similarly equipped, but the results were disappointing. Not only was the small craft "painfully slow," making only 5 miles per hour on the downstream trip, but it was also too cramped to accommodate sleeping quarters. The passengers were forced to camp out, as they had done on the earliest work boats within the District. By 1904, the District's search for the most economical and efficient source of fuel had led to the conversion of its dredges to oil burners.

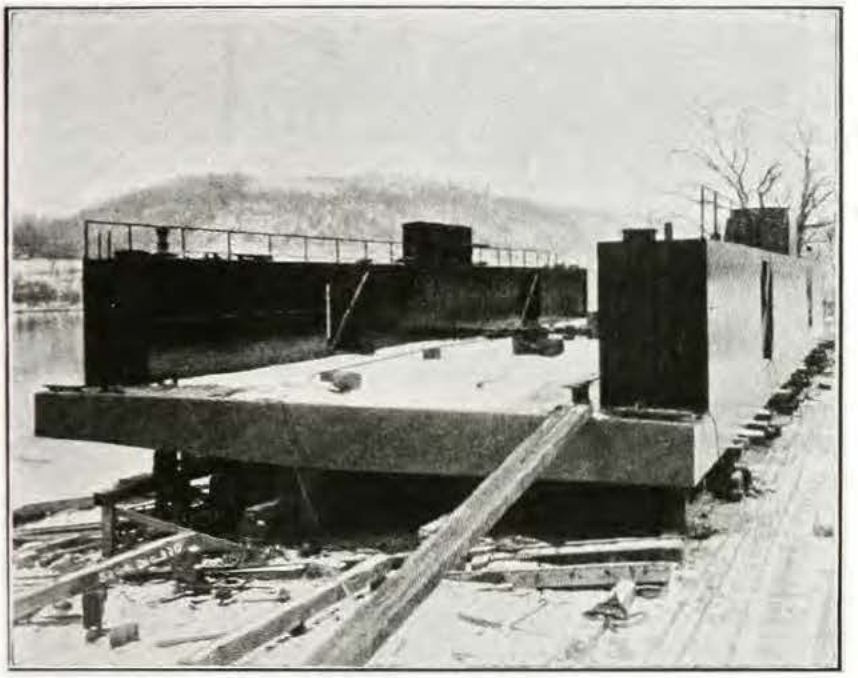
As other technological advances were achieved, the operations of the District became increasingly modern. The telephone was introduced into the District in the summer of 1894. At the rate of $13.50 per quarter, the Vicksburg Engineers had at their disposal the use of the lines of the Great Southern Telephone and Telegraph Company. The year 1905 brought the introduction of electricity at a lock and dam site on the Ouachita, and natural gas pipe lines were laid to a similar site in 1919.

Two basic ideas governed the plant purchases during this period: economy and quality. Fighting the old congressionally favored system of purchasing equipment for each job out of the funds allotted to that job, and restricting the use of that equipment to that job only, the Vicksburg Engineers sought to develop and maintain a central plant which could be used on any and all of the streams as needed.

At the same time, the District firmly believed in the principle of buying the best equipment available. Although the initial cost usually was greater, it was still possible to effect considerable savings in the long run. The extensive plant being developed required a vast amount of maintenance. The cheaper the equipment, the more easily it broke or deteriorated. For example, boat and barge hulls made of untreated wood rotted after 6 or 7 years of use in the hot and humid climate of the lower Mississippi Valley. Vicksburg's experienced Engineers soon insisted upon hulls of creosoted lumber or steel, and they increasingly succeeded in getting them.

One of the greatest handicaps faced by the Vicksburg Engineers in the operation and maintenance of its plant resulted from its lack of facilities for making repairs. In 1892 Captain Willard complained to the Chief of Engineers that there were no facilities for repairing vessels within 300 miles of Vicksburg. New hulls had to be delivered from New Orleans or from plants above Cairo. Willard sought, unsuccessfully, the needed authority to build his own hulls on the lake at Vicksburg using hired labor. In 1898, 1904, 1906, and again in 1909, successive District Engineers at Vicksburg complained because their damaged equipment had to be taken to New Orleans or Greenville for repairs.

By 1912 the problem had been alleviated. Captain Clarke S. Smith succeeded in obtaining authorization for a dry dock that the



New steel dry dock for Third (Vicksburg) District

1893 PLANT BUDGET
YAZOO RIVER PROJECT

General service plant.		
Dredge	$30,000	
Pile-driver	4,000	
Quarter-boats	2,500	
Skiffs, tools, rigging, etc	3,500	
		$ 40,000
Service of plant.		
Expenses of snag boats	24,000	
Expenses of dredges	9,000	
Expenses of shore parties	7,000	
		40,000
Care of plant.		
New boilers	4,000	
Hull repairs	3,000	
General and extraordinary repairs	1,500	
Fleet, wages, supplies, etc	1,500	
		10,000
Surveys.		
Local surveys, gauges, discharge measurements, etc	6,000	6,000
Administration.		
Office expenses, rent, supplies, etc	1,500	
Assistant engineers, draftsmen, transportation, and incidentals	2,500	
		4,000
Total		$100,000

(From Annual Report, 1893, p. 2027.)

Clarke S. Smith

Charles S. Bromwell

District could use jointly with the Third District of the Mississippi River Commission. The steel structure that he ordered boasted a length of 156 feet and a breadth of 56-1/2 feet. Vertical steam engines were connected to an 8-inch contrifugal pump which allowed the dry dock to be sunk under a steamboat, towboat, or hydraulic grader and raise the damaged craft out of the water for repairs.

CHANNEL CLEARING

Throughout the miscellaneous operations of the Vicksburg Engineers, continued advances were made in methods as well as in equipment. Buried logs and snags formerly were left in the river's channel when they could not be removed were now removable, as the Engineers devised a successful means of poling explosives to their bases. Meanwhile, the increased power of the snagboats permitted them to be used, in many cases, to pull live trees from the channels that formerly were not removable.

EXPLOSIVES USED MOUTH OF YAZOO RIVER, FY 1895

Judson powder, 26,387-1/2 pounds	$3270.68
Dynamite, 7,794 pounds	975.78
Platinum fuses, 13,450	344.95
Total Cost	$4591.41

Despite the initial fears when explosives were introduced into the District, their increased use was characterized by a better-than-average accident record. Throughout these four decades, there has been no recorded loss of life resulting from explosives used in channel clearing or channel dredging activities within the District. The only near-miss on record occurred at a farm above Shreveport, when an exploded stump sailed through the wall of a tenant house and damaged two bedsteads in which children were sleeping. The Vicksburg District, without question, paid the tenant family for the damages claimed: $5 to repair the house and $16 for the two bedsteads.

The perennial problem of channel clearing became even more difficult after the turn of the century as the District's waterways became infested with a new form of plant life. The waterhyacinth was a charming, innocuous-looking flower, but it was also a fast-spreading, stream-choking pest. As it pushed its way up from the Gulf Coast, it not only filled the channels so thickly that boats could not navigate but also despoiled the streams of their natural ecological balance.

The first complaint against hyacinths in the Vicksburg District was made in 1903 when they first appeared in the Sabine River. District Engineer Charles S. Bromwell requested and received a special allotment of $500 to rid the stream of its new pest. Bromwell was unduly optimistic. By August 1904, a new District Engineer at Vicksburg was sending samples of the plant to Washington in search of an appropriate poison to accomplish what the District's machinery could not. A combination of arsenic and soda

Waterhyacinth, a prominent water weed in large areas of southern North America

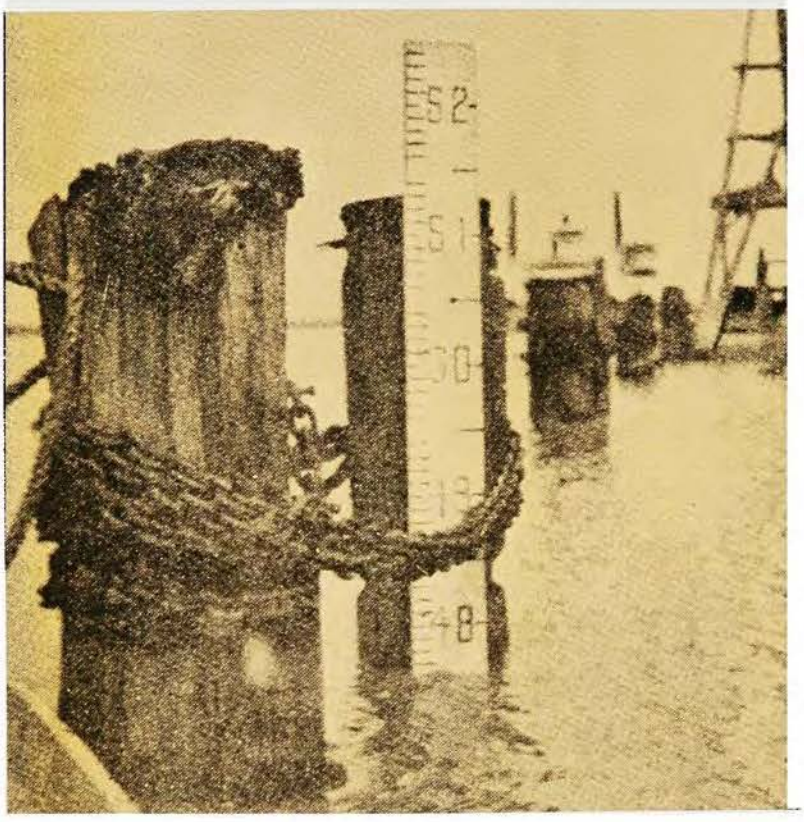
eventually proved to be the most effective solution in destroying old growth, but the winds and the currents constantly spread the seeds of the parasitic plant, and waterhyacinth control became a lingering, though not especially serious, problem for the Vicksburg Engineers.

NAVIGATIONAL AIDS

Almost since their arrival in the District, Vicksburg's Army Engineers had been responsible for the establishment and maintenance of water gages and navigational bulletins along the major waterways in the District. At strategic sites, the Engineers placed gages, marked off in feet and tenths of a foot, to measure the fluctuations in river height and its influence upon river channels. Large bulletins which reflected the readings on key gages and were legible at a distance of half a mile were placed at easily seen locations to aid rivermen and render navigation more safe—a particularly important service in the years before rivermen became dependent upon radio communication.

Again the Army Engineers in the lower Mississippi Valley faced problems peculiar to the area. The wooden frames of the traditional bulletins and gages rotted rapidly. Painted marks on the gages were effaced rapidly. Moreover, the iron plates on the bulletins frequently bent and would not fit their grooves, and the actual mounting of these plates in strong winds was extremely dangerous. Numerous alternatives were tried, and many were discarded. Aluminum plates were too expensive; fiberboard lacked sufficient rigidity.

By 1897 Captain Willard had devised a satisfactory plate of wire mesh, with metal numbers and characters riveted in place. Wrought-iron pipe replaced the wooden frames of the bulletins. The gages continued to be made of wood, since these were moved with greater frequency, but the old painted marks which rapidly faded were replaced with gradations branded through iron stencils and numerals with copper dies.



Gages on the Mississippi

River bulletins note a falling river

REVETMENT

The area of bank stabilization could be considered the Vicksburg Engineer's greatest contribution during this period. Caving, sliding banks were an incessant problem. Enough soil fell into the Mississippi, alone, each year to fill that river to the top of its banks for a distance of 30 miles. This river, as well as several of its tributaries, has well earned the reputation of being "too thick to drink and too thin to plow."

As these banks slid into the rivers, whole towns sometimes fell with them. More often, a few blocks at a time caved into the channel, and the towns retreated. Along uninhabited stretches, trees and other debris were washed into the currents as the banks gave way; costly levees collapsed and swirled away; valuable arable lands were lost to cultivation. Downstream, the accumulated materials would join and form navigational obstructions or natural dams which caused waterways to flood. The gnawing currents ate away at river bends and cut channels across their necks, often isolating towns or creating problems with channel depths and scouring.

Revetment is the engineering process designed to repair those banks, to fortify them against the wash, and to patch the river bottoms at points of dangerous scour. It has always been a multifaceted procedure, with

Silt from this erosion could later show up in the form of sandbars, downstream

Fascine channel mattress for bank protection on lower Mississippi being ballasted just before sinking.

different techniques used in different areas and different periods. In the early years a good coat of grass sometimes held the slope above normal water level. If not, then a layer of riprap, broken stone and brush, or a combination of stone, brick, and lumber usually sufficed. Below the normal water level, however, an entirely different and more complex problem has existed. Moreover, the changing needs of society have generated a continuous quest for improved methods of revetment.

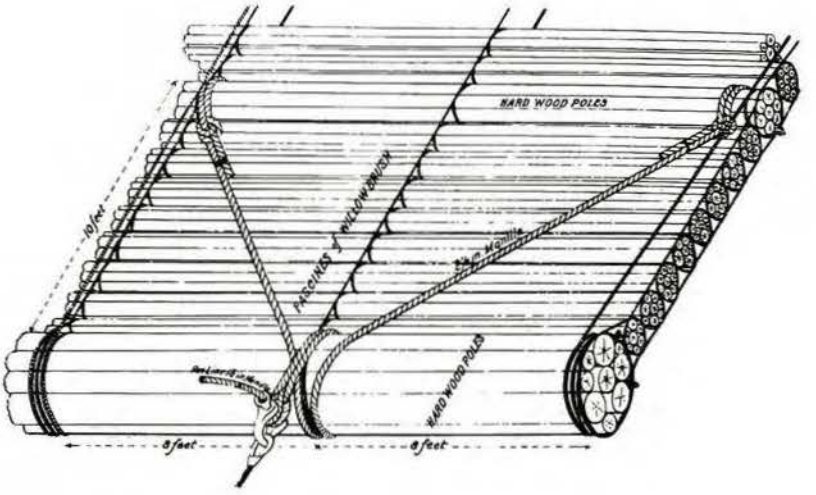
An effective revetment for subaqueous banks would require two qualities—economy and strength. The earliest engineers in the valley felt that the indigenous willow trees offered the best material available. The French engineer de Pauger recommended a primitive type of willow revetment in the 1720's. Again, in the 1840's, another continental engineer, M. Tomasi, visited the lower valley and recommended his own modification of this principle, treble lines of stout willow trees planted along failing embankments. Unfortunately, Tomasi's idea had one major drawback—living willow plants multiplied rapidly and soon choked the smaller streams. This already was such a constant problem for the Vicksburg Engineers that they would never have entertained seriously Tomasi's idea of planting additional willows in any waterway smaller than the Mississippi. Even on that main stem, it was not considered by America's engineers to be the most feasible method available.

A modification of the Tomasi-de Pauger idea was selected by the Army Engineers in their initial revetment work. Young willows were felled, slender stalks 3 to 6 inches in diameter and 40 to 50 feet long. Work parties stationed on flat barges wove these willows into huge mattresses 250 to 300 feet in width and in a standard length of 1000 feet. With the aid of considerable quantities of rock, often from the Corps stone quarry at Searcy, Arkansas, the mattresses were sunk and anchored against the subaqueous banks.

The woven willow mats satisfied a number of requirements. They were flexible enough to handle and could be adjusted to the irregularities of the riverbank or bottom. They were also the most durable means of revetment yet devised; but they had shortcomings as well. A mat could not be woven with equal stress at all places; often the mattresses ripped at weaker points. Too, the work was tediously performed by hand, and labor was often short, particularly in the cotton seasons.

With time, the willow mats were modified. Woven mattresses were replaced with new "fascine-type" bundles of parallel willows held together by cribbing poles and sewing wire. Still, the revetment system did not satisfy all needs. The willow mattresses would never be permanent. Natural deterioration of sunken wood could not be circumvented. Also, by 1910, willow trees were becoming scarce. Experiments were undertaken to find a more effective substitute.

Fascine mat assembly



Mat is assembled by labor forces on the site

Rock is piled on floating mattress for ballast

Mat in place, remainder of willows are below water level

In 1914 the Third District of the Mississippi River Commission, also stationed at Vicksburg, began its first studies of reinforced concrete as a revetment material. Sand and gravel dredged from channel bottoms and bars were recycled into concrete and shaped into a variety of sizes—alone and in combination with a number of reinforcing materials.

D. M. Shearer (right) patented the concrete mat

By 1917 a successful "articulated concrete mattress" had been devised. Slabs of flattened concrete, 3 inches thick and just less than 1 by 4 feet in breadth, were reinforced with 12-inch wire mesh which extended slightly on all sides. Wire cables ran through the mesh of consecutive mats, linking them together into a broad, vast roll which could be uncoiled down the slope of a caving bank and ballasted with concrete blocks of 64-pound weight. Much work still remained to develop improved machinery for processing these mats, but the accomplishment of the Vicksburg Engineers was still significant. A permanent means of revetment, at an affordable price, was now a reality in the lower Mississippi Valley.

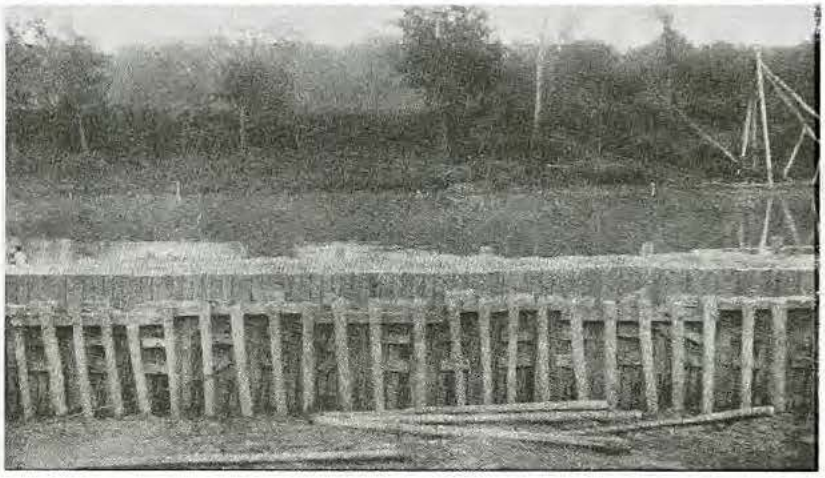
Concurrent with the problem of developing a suitable revetment material, the Vicksburg Engineers also faced a need for better means of bank grading. Again, numerous methods were tried and discounted in their incessant quest to develop the ideal. In converting caving banks into stable slopes, the Nation's engineers were using high-pressure water jets to wash away the banks in strategic points. Initially, these hydraulic graders operated on a direct-action, plunger-pump principle. Vicksburg Engineers, in 1909, refined the method with the construction of a grader powered by steam turbines and centrifugal turbine pumps. With the new innovation, pump pressure increased 80 percent, and the efficiency of their labor increased for years to come. Yet, the District's Engineers remained unsatisfied, continuing experiments to develop a mechanical grader which would slope banks even below the water level.

Blasting stumps to make way for levees

Earliest articulated concrete mat launching boat (about 1918)

Outside view

Inside view



Big Sunflower Lock, modified box cofferdam, 1914

DEMISE OF SMALL STREAMS

As America dashed headlong into the twentieth century, the fabric of its society underwent a number of changes that seriously affected the scope of engineering activity within the District. The mushrooming growth of railroads before the turn of the century had virtually killed the steamboat era. Numerous smaller streams were abandoned by the navigation interests. By 1902 one steamboat line informed Vicksburg's District Engineer that the torturous Yalobusha River, for example, was as good as dead. "Traffic there would not support a catfish," he swore. World War I development of the Federal Barge Line increased commerce considerably on the Mississippi and its major tributaries, but did little for the commercial rebirth of the backcountry waterways. As years passed without any significant navigational activity on their waters, many small streams had to be abandoned by the Corps.

Within the Vicksburg District, only four rivers other than the Mississippi survived economically to any significant extent: the Yazoo, the Big Sunflower, the Ouachita, and the Red. On each of these streams the Corps conducted considerable improvement works. The most extensive surveys to date were conducted on the Red and the Ouachita, and general improvements that followed generated commercial growth to the point that railroad freight rates in these areas dropped 25 percent to meet the waterborne competition. The construction of a single lock and dam of the new box cofferdam design effected a similar increase in traffic on the Sunflower.

The opening ceremonies of the diversion canal at the Vicksburg Riverfront gave the hundreds in attendance hopes that the Hill City would return to its status as a river boom town

YAZOO DIVERSION CANAL

The problem of the Yazoo River was an entirely different one. Indeed, it was a double-faceted problem. This major tributary of the Mississippi had been given its name by the primordial Indians—a name that meant "Waters of Death." Captain Willard did not agree with this evaluation of the river. Willard, in fact, considered it "an ideal stream," with "uniform slopes at all stages.... Even in extreme floods, the current can never attain destructive speeds."

The major problem with the Yazoo was the shifting bar of sand and gravel washed down from the high adjacent hills that obstructed its entry into the Mississippi. Many boats, particularly the small, gasoline-powered motorboats introduced about the turn of the century, could navigate the bar only with extreme difficulty. Accompanying this problem was Vicksburg's lack of access to the Mississippi River, occasioned by an earlier cutoff which had not been countered successfully by the poorly funded Engineers.

Initially, the Army Engineers concentrated on the restoration of the city's harbor rather than the problem with the shifting bar. By 1890 a basin was dredged out in front of the town and a new canal connected it to the Mississippi. But the work was not permanent. Throughout the 1890's, sediment continued to clog the channel until it was passable only when the water in the canal rose to its highest stages.

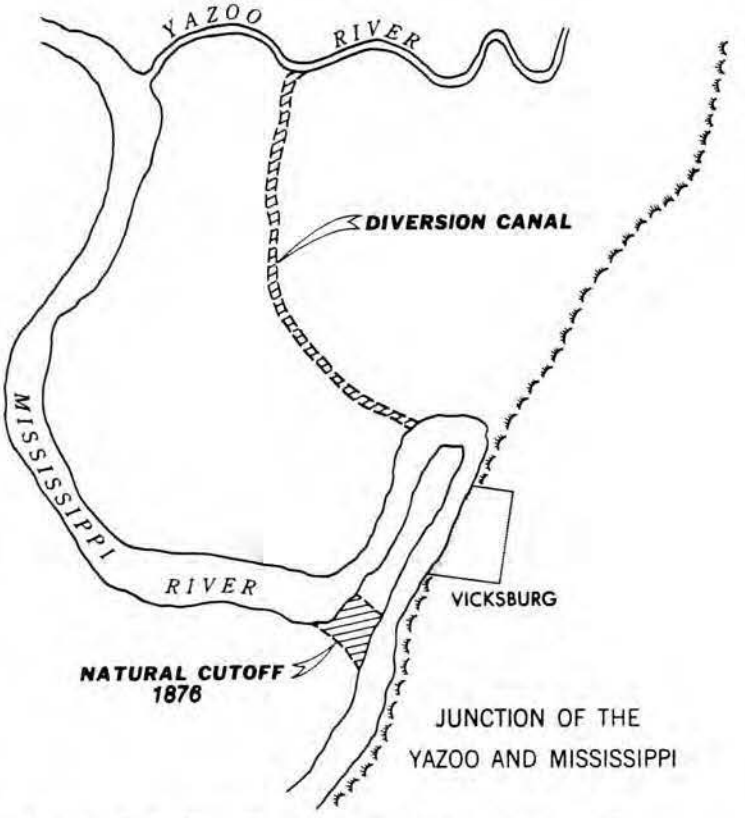
Captain Willard was seriously concerned over both problems. The city of Vicksburg was losing much of its commerce. The 800

navigable miles of the Yazoo River system meandered through country being rapidly settled, especially by America's displaced black population. The preservation of the Vicksburg harbor and the maintenance of navigable waterways throughout the system was an urgent necessity, and it would attract new settlers as well.

In fact, the captain had taken the matter into his own hands and experimented with jetties on the mouth of the Yazoo. But, he soon was forced to admit that any such action without a tremendous and expensive amount of preparatory work was hopeless. The sand was so deep and its suction power so great that when a careless overseer dropped the hammerhead of the pile driver, it went through the sand so fast it could not be followed with a long pike pole.

The Army Engineers and the city of Vicksburg conducted cooperative surveys to determine the best methods of alleviating the area's woes. The final reports of Thomas G. Dabney, the civilian engineer who conducted the city's survey, were forwarded to Washington along with the annual reports of Major Willard. It was suggested that the waters from the Yazoo be diverted to form a new outlet from the former mouth of the Yazoo on Old River, through that old channel, across the lowlands to Lake Centennial, around the head of DeSoto Island, and past the front of Vicksburg on its way to the Mississippi River at a point on the channel side. The

Dike at Vicksburg separating Yazoo Canal at Mississippi River is blasted



plan was approved and funded by Congress in 1892.

Numerous problems were encountered in the subsequent work. Enterprising local citizens placed inflated values on their land when the Engineers approached them to purchase rights-of-way. Once work began, alternating high and low waters flooded the area or precluded the towing off of timber. Contractors assumed projects with insufficient plant. When it proved necessary to dam the West Pass to Lake Centennial, a lumber company filed suit for damages, claiming that it was being denied access to its usual route to the mills.

A tight-fisted guardian of Federal funds, Willard imposed every savings possible. Clearing and grubbing of rights-of-way were done by hired labor rather than by the more expensive, but more customary, method of contracting for the work—even though it necessitated increased supervision on Willard's part. The District Engineer also persuaded Congress to let him operate on a "continuous contract system." Rather than work until funds were exhausted, then lay off the crew and lay by the equipment until new funds were appropriated, Willard was authorized to purchase materials on credit to be paid for out of future appropriations whenever necessary, up to a limit of $400,000 a year.

By its completion in 1905, the project had cost more than $1 million. Maintenance costs in subsequent years, before the supervision of the work was transferred back to the Mississippi River Commission, would average $8000 per year. Yet, on the cost-benefit scale, the project was deemed very successful. Shipping rates plummeted for the $9 million in annual commerce generated in the area, some 33-1/3 percent on cotton seed, 50 percent on cotton, and 66-2/3 percent on livestock.

The benefits of the canal were not universal, however. In fact, its construction involved the Corps in its first water pollution suit within this District. The year before the completion of the canal, it became obvious that a serious problem was impending. The dumping area for city sewage lay between the diversion canal and the city. Waters from the canal would wash the sewage to a point downriver where the intake pipes of the waterworks were located. The water would certainly be unfit for domestic use, since such situations spread typhoid fever and similar diseases.

Indisputably, the problem was a serious one. The Vicksburg Water Works notified the Corps of Engineers that a damage suit would be filed, and the matter was relayed promptly to Washington by the district engineer for appropriate action. Yet, there was no constitutional nor legal basis upon which the Engineers could obtain the funds to move the waterworks. Neither could they abandon the nearly completed project. Vicksburg's

Engineers were advised by Washington to suggest the replacement of the sewage dump or the intake valve by the city itself. The financial liability of the Corps could only be decided by the U. S. Courts or by the Congressional Court of Claims should the city decide to press the issue.

CHANNELIZATION OF THE OUACHITA

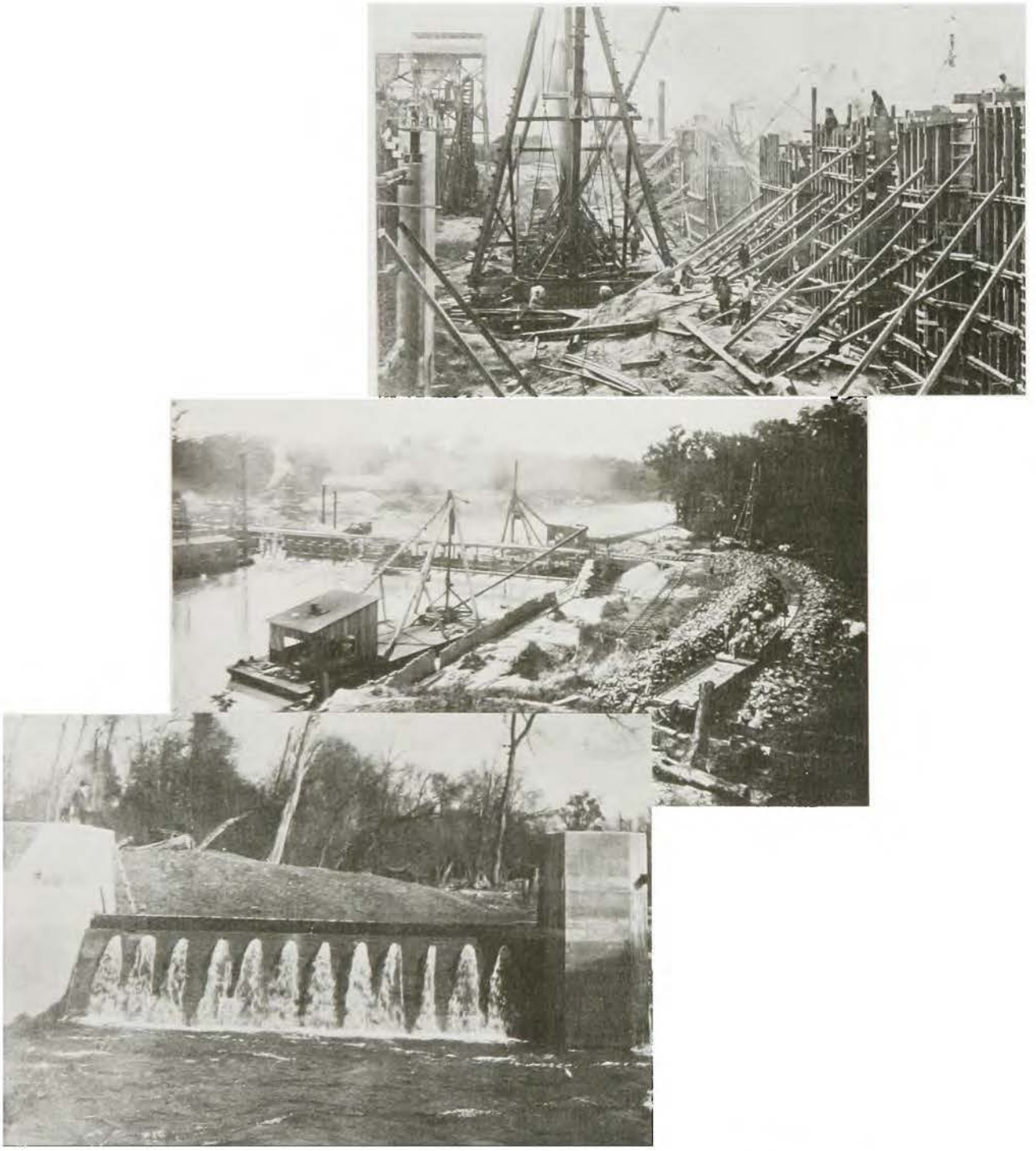
The most extensive navigation improvement work undertaken by the District in this period was the achievement of a 6-1/2-foot channel in the Ouachita River through a system of locks and dams. Residents of this river's valley long had pushed for this work. The idea had almost produced results in the 1870's but was abandoned because of declining river traffic and the high cost of the needed work. Throughout the 1880's and early 1890's, Arkansas business leaders pressured their congressmen to call for a revival of the project.

In 1894 a new survey of the river was funded. Prospects for the completion of the proposed project seemed good. Commerce was on the increase on this stream, while declining on many others. The costs of materials and transportation were decreasing. However, no effective project could be planned without considerable preparatory study. Conflicting claims were coming from all quarters on the issues of projected costs and benefits. No sound technical information existed on the best locations for the dams or the amount of land which might still overflow after the work was completed.

The last consideration was of prime concern to Captain Willard, a businessman as well as an engineer. Without such precise information in advance, Willard informed his superiors, his office would have little defense against later damage claims that might result. As the captain put it: "A railroad company is always so unlucky as to kill only the finest stock; and so, lands abandoned for taxes and given up to wild game,...might come to be the finest agricultural lands in the valley, and rise from ten cents to ten dollars [per acre] by the location of a dam."

Also, Willard insisted that new surveys, with leveling by methods of precision and with the planting of stone marks underground at short distances, were essential to the accuracy of the work and would prove to be more economical in the long run than the more primitive methods.

The surveys initiated by Captain Willard resulted in Congressional authorization, in 1902, of the construction of a 6-1/2-foot slack-water channel from the mouth of Black River to Camden, Arkansas. For 360 miles, the Black-Ouachita system would be navigable year-round. From 1902 to 1925, the Vicksburg Engineers pursued the completion of the channel, improvising new cofferdam constructions to suit the Ouachita's "sensitive" nature and revising and adapting their plans to provide the most modern system available with the funds provided. The results of the completed project were gratifying. In the calendar year immediately prior to the opening of the last of the locks and dams, the commerce of the Ouachita below Camden amounted to $1.8 million. In the year following the project's completion, commerce rose to $9.2 million.



Construction of locks and dams on the Ouachita River during the 1912 working season

The Vicksburg Engineer Office assumed a major portion of the responsibility for construction in the blossoming Vicksburg Battlefield Park. Construction of the Illinois Monument (note state flag) represented one of the great architectural achievements in the park

EXPANSION OF DUTIES

The twentieth century brought radical changes in the society of the lower Mississippi Valley. In 1910 Assistant Engineer (civilian) E. C. Tollinger, reported to the district engineer:

> *While the statistics may not show any great increase in population, railroads, municipal improvements, etc., in the District, a much greater progressive spirit, which is laying the foundation for future progress, has been developed in both city and country. This is exemplified in the cities by greater attention to sanitary and moral conditions, and other municipal matters, an increase in educational and social institutions, a growth in banking facilities and finance, better buildings, more automobiles, and a greater public spirit.*
>
> *In the country it is exemplified by a closer personal attention of proprietors to their plantations, better agricultural methods, more artesian wells, better health conditions, and a greater attention to drainage, good roads, and other movements for general improvements.*

As the structure of society changed, the responsibilities of the Vicksburg Engineers broadened considerably. Their district engineer, at the turn of the century, was assigned the responsibility of directing the construction of the National Military Park in that city. The passage of the Refuse Act of 1899 required the Engineers to investigate, authorize, or overrule any activities which might result in the obstruction of the District's waterways, as in 1902 when the Greenville City Council sought permission to erect a dump which emptied into the Mississippi River.

Similarly, any private activity which affected the navigability of a stream had to be approved first by the Engineers at Vicksburg. In 1908, for example, the Lancashire Compress Company of Memphis sought permission to establish a floating cotton compress outside Vicksburg. Considerable demand for the service already existed, and the district engineer agreed that the proposal would greatly benefit the economy of the region. However, the company sought to locate the plant between the mouth of the Yazoo and the steamboat landing—a position which would have placed it in the diversion canal. Since

Dedication of state memorials, such as the Illinois Monument, drew crowds from northern states as well as nearby Vicksburg to the new National Military Park

such situations were expressly prohibited by the adopted "Rules and Regulations for the Control of the Yazoo River Diversion Canal," it was the district engineer's task to suggest a more suitable location.

Again, the Vicksburg Engineers were called often to serve as advisors for bridge companies and as representatives of the navigational interests against bridge companies that improperly blocked waterways. By the 1890's Congress required that all plans for bridge construction be cleared with the Corps of Engineers in that region. Submitted plans were carefully studied and public hearings held to weigh all viewpoints. If any existing bridges were found to be obstructions to navigation, the district engineer was required to investigate and suggest necessary changes. If all else failed, he was authorized to remove the bridge at the owner's expense. Even the regulation of drawbridges to assure their proper opening and closing, as specified by law, was assigned to the Corps.

Particular problems arose with the drawbridge planned by the Natchitoches Railway and Construction Company at Grand Ecore, Louisiana. This corporation was not a private company in the usual sense, but was an arm of the Natchitoches Parish Police Jury organized to handle the actual contracting between the parish of Natchitoches and the bridge contractor. The planned railway and traffic bridge was to be a free public structure, financed by the town and parish of Natchitoches and by private donations, as a general community improvement. It also was to serve as an extension of a railroad tract that linked the port of Grand Ecore with the town of Natchitoches which had been stranded without a harbor since the Red River changed its course in the 1830's.

The Vicksburg Engineers approved the plans and Congress granted the required authority. Construction began in 1900. Within a year, navigational interests were complaining that there was insufficient channel opening on the shore side of the pivot pier. Washington suspended the general approval for the work until the district engineer could arbitrate settlement between the two conflicting groups. A compromise was reached, work resumed, but—after 27 months—the Railway and Construction

George P. Howell

Thomas C. Thomas

Company still had not fulfilled its end of the agreement. Again the work was suspended, and a public hearing held.

The parish representatives (George W. Kile, president of the Police Jury, and D. C. Scarborough, president of the Railway and Construction Company) were apologetic, complimentary, and conciliatory. Financial hardships had prevented the civic groups from making their promised alterations. Their problems had been solved recently; yet they were not able to say how long the action would take. Indeed, they were not sure how to go about correcting the situation. Upon their request, Captain Bromwell personally visited the site and devised a simple corrective procedure.

In this case, the Corps showed both restraint and understanding in dealing with an apparently recalcitrant organization. The alternative could have been the removal of the bridge or a Corps-conducted alteration at the expense of the parish of Natchitoches in a period when the parish could not meet the costs. Both options would have meant hardships on the people of the area. However, with the cooperation of the parties involved, the problem was brought to a satisfactory solution with the least amount of hardships to all concerned.

WARTIME CONTRIBUTIONS AND CONDITIONS

The Vicksburg Engineers were twice engaged in wartime activities in the four decades that prefaced and followed the turn of the century. The first involvement occurred in the course of the Spanish-American conflict. The District's major snagboat, the *John R. Meigs*, had been the backbone of the government plant on the Yazoo River since its construction in 1879. For most of that time, it was under the command of an equally capable river veteran, Captain P. R. Starr. With the outbreak of hostilities, Captain Starr and his *Meigs* were transferred to the New Orleans District to help prepare the defenses at the mouth of the Mississippi River.

On 3 September 1898, Captain Starr and a small crew were employed in raising and placing torpedoes in the Mississippi River near the Gulf Coast forts of St. Philip and Jackson. One torpedo exploded killing the captain and four crewmen. The helpless boat drifted to the shore and sank in deep water. In eulogy, Major Willard reported to Washington: "The destruction of the *Meigs* and the death of its master were a great loss to the District,...and by his death, I lost a zealous assistant, faithful in the discharge of every duty intrusted [sic] to him."

The erruption of World War I affected the District in a different way. The district engineer himself, Lieutenant Colonel George P. Howell, was transferred to the war effort, and the demands of the national emergency did not allow for a replacement. The responsibilities of the office were fulfilled in the interim by one of the most capable civilian employees in the organization, the long-time assistant engineer, T. C. Thomas.

Similarly, a shortage of manpower affected the operation of the District in all of its operations. On the Red River, the Yazoo, the Tallahatchie, and the Coldwater, the shortage of laborers handicapped even the routine clearing work. The lock and dam project on the Ouachita was held up by a shortage of material as well as men.

ADMINISTRATION

Throughout these four decades, rapidly advancing technology, new social ideals, and the expanded duties of the Corps brought about significant changes and growth in the administration of the District. Federal regulations, political interference, dissatisfaction among certain segments of the population, restless crews, overambitious employees, a mushrooming plant, and shrinking space all posed particular problems.

In 1891 the Vicksburg District Office of the U. S. Army Corps of Engineers was quartered in a rented house. In the spring of that year, the office was asked to vacate the premises so that the owner could resume his residence in the structure. The alternative was to have the rent raised to an *exorbitant* $60 a month.

Captain Willard was worried. No other rental buildings of sufficient size were available which could provide working space for his chief clerk, three draftsmen and several copyists, his correspondence clerk, property clerk, and voucher clerk, his gage assistant and general assistant, his assistant engineers and their clerks, his computers, and the office messenger—or house his instruments, drawing materials, records, map cases, drawing tables, stationary and office supplies, or blue printing-photography and draftsmen supplies.

Those buildings nearest in size to the needs of the District, although they still fell far short, were all located in the heart of the business district. Willard, literally, had nightmares, as he imagined the many disadvantages and dangers that such a situation would present. The downtown buildings were of "poor construction, usually of two stories, with narrow stairs and without ventilation—an important matter in this hot climate." Moreover, they were extremely susceptible to fire. Some thirteen stores, in fact, had burned within a four-block distance in the past 6 years alone—with an accompanying loss of forty lives.

The Vicksburg District in 1891 was responsible for an area that covered 200,000 square miles and included parts of Tennessee, Mississippi, Louisiana, Arkansas, Texas, and Indian Territory (Oklahoma). Its payroll listed sixty-nine fulltime employees (all male) drawing a combined monthly salary of $2,290. Its accumulated survey notes and maps alone—Willard estimated—could not be replaced for less than $200,000 and five years of labor. The instruments and other property

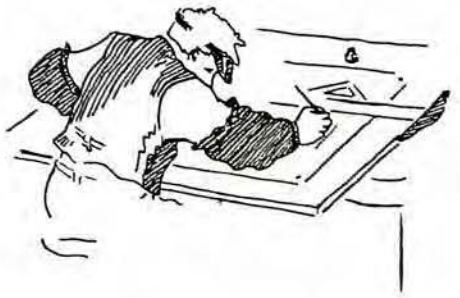
The "new" Post Office and Customs Building housed several Federal offices but the Corps of Engineers could only squeeze out attic space for their offices and working area

under his charge were valued at $10,000. Under the weight of this responsibility, the harried district engineer bombarded the Office of the Chief for relief that year.

Conveniently for this engineering office, a new public building was being constructed in Vicksburg, on the southwest corner of Crawford and Walnut Streets, by the Federal government. Although designed primarily to house the post office, it also contained numerous additional rooms which were to be let out to various government agencies. The brick structure, moreover, was fire resistant. Willard personally inspected the building, obtained blueprints, and then barraged Washington with a series of requests for accommodations, each request containing an alternate proposition.

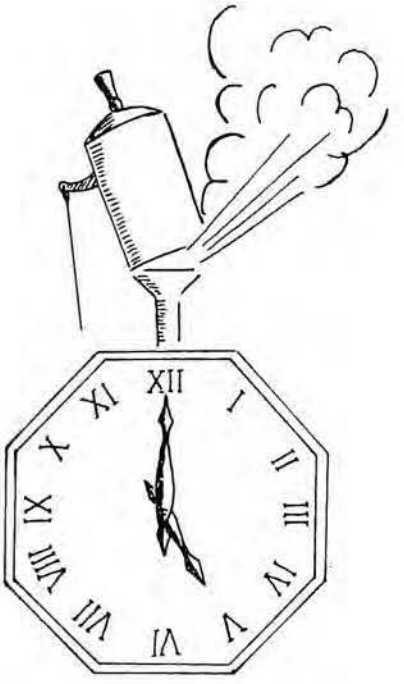
Three rooms were offered to the District, but the Engineers insisted they must have more. If they could be given the wide corridor as well, they would partition and convert it into useful space. If necessary, Willard promised, they would be content with offices scattered over two floors—but not three. Electric bells and speaking tubes could provide communication between the floors. Their furniture needs were small. The four rugs he requested could be made locally at little expense, but good gas fixtures were imperative as his force often worked at night to complete reports. Above all, he certainly would not request the one suite of rooms in the building that sported a fireplace, since there was already too much contention for those quarters. Months of bargaining brought some small results. Willard and his office were assigned a cluster of rooms on the attic floor.

In most respects, Captain Willard was justified in his worry over the possible loss of Engineer records and instruments. The maps of the Vicksburg District in this period were certainly among the best available. Draftsmen replotted all of the old original maps drawn on tracing cloth and distorted with age, and the paper used by the draftsmen was of the highest quality. Any irregularities rendered it unacceptable to Willard. The latest techniques



and mechanical processes were employed. Experiments were continually conducted to produce the best quality work with the greatest savings in the least amount of time. Even the hypsometry and hydrography notes were indexed promptly.

On the other hand, equipment considered primarily for personal convenience was appraised judiciously before any purchases were made. Willard gave in to the demands of his clerks in 1888 and ordered a new Remington typewriter for correspondence—being careful to extract the best bargain possible from the company. In 1894 he "splurged" again on the purchase of three Columbia bicycles for his topographers, each with pneumatic tires, bell, tool case, travelling case, and cyclometer. The typographers were extremely grateful. William R. Neely rode one of the cycles daily to his work on the Yazoo



River Diversion Canal, a 10-mile round trip, and ecstatically praised the savings in time and bodily fatigue. It had previously required him 1-1/2 hours to get to work by horse and buggy, or 3 hours if he walked. By cycle, he now made the trip in a short hour.

Within 7 months, the bird-dogging, budget-watching district engineer reported to his chief a savings of 20 hours over horse and buggy time and 80 hours over walking on the Yazoo project alone. "The wheel is in perfect repair," Willard reported. There had yet been no accidents. "I consider the result of the experiment a positive gain to the works under my charge," the captain announced in conclusion.

The working conditions of the employees within the District underwent considerable improvement in this period. In 1890 the Federal government followed the national trend toward the 8-hour workday. Immediate instructions were issued to the Vicksburg District to comply with this regulation. In general, the District engineers and their project assistants complied whenever possible, but the very nature of their work, much of it performed on an emergency basis, made total compliance impossible.

By 1892 paid "vacations" and "sick leaves" were observed on a very general basis. No

Gravesites of workers who succumbed to perils of the Ouachita River Lock and Dam No. 3 project

uniform rule existed within the Engineering Department of the Army. In its absence, the department followed the pattern established by statute for the other military services and several other government departments. Each employee was allowed a credit of 30 days absence in a calendar year without a cut in pay and without regard to reason. Pay would be deducted for each day missed thereafter.

Work on the Corps boats still remained a hazardous occupation. Laborers drowned and were felled by trees; they chopped their fingers off with axes and removed their hands with saws. They hammered their thumbs along with the pilings and were slapped by swinging chains. Hematuria, smallpox, yellow fever, malaria, and measles continued to infest the work boats. Surveyors stayed in the marshes too long, wrecked their health, and were forced to retire to "teaching at Baton Rouge."

Despite the impression given by this litany of occupational hazards, Vicksburg's district engineers did strive to improve the lot of workers throughout the District. Captain Willard, for example, insisted that his draftsmen and topographers rotate field and office duties rather than expose themselves too long to the debilitating effects of the swamps and marshes. When two employees contracted measles near Shreveport, he arranged for them to be treated at the U. S. Marine Hospital in that city, and then harrassed Washington to approve his unprecedented action and grant blanket approval for future incidents. Continued concern was expressed by each successive officer in charge over the safety of the work boats and perennial pleas were made to an often unsympathetic Congress to authorize the repair or replacement of hazardous or potentially hazardous vessels.

Medical supplies were carried on each boat from the time the Engineers first began their systematic work in the District, but a physician's care was needed in many cases. When Washington failed to authorize such an expenditure for two smallpox victims in 1910, District Engineer Clarke Smith sent the bill back to his superiors and insisted that it be reconsidered. Smith then waged a successful campaign to hire a physician and surgeon to be

Steamer Joseph E. Ransdell *snagging logs in the lock chamber at Lock 6, January 1913*

stationed at Franklin Shoals, an isolated spot on the Ouachita Lock and Dam project.

As work continued on the Ouachita and Sunflower dams, increased conveniences were provided for field employees. A lockkeeper's dwelling was built at the Ouachita Lock and Dam No. 4 at a cost of $4800 in 1905. At Lock and Dam No. 3 in 1919, two camp buildings were remodeled for use as residences for the lockmaster and the lockman. Again the following year, another lockman's cottage and storehouse were renovated and a concrete floor was added to the storeroom, and a camp building remodeled as a cottage for laborers. Throughout the District, work parties along the rivers were moved from field tents to well-equipped quarter boats.

DAILY WAGES
At Lock and Dam Sites, 1914

	Ouachita River	Sunflower River
Foreman	$3.00	$3.00
Engineman	2.50	2.50
Laborer	1.65	1.75-2.00
Stoker	1.50	1.75

Rations provided free .50 value

Yet, despite improved conditions, many of the old personnel problems persisted. Foremen, laborers, and laundresses were castigated, suspended, and fired for drunkenness. At least one overly ambitious laundress was accused of moonlighting with the male employees, although the vessel's master vehemently denied that the woman kept such assignations. When the work parties neared towns, saloons were always an enticement. On free weekends, crew members drank, fracased, and shot each other to the frustration of their supervisors.

Pressures from politicians and private interest groups were an increasing source of annoyance throughout this period for the engineers at Vicksburg. Disgruntled, over-the-hill rivermen who could not obtain employment elsewhere sought their congressmen to apply political pressure on behalf of their applications for jobs with the Corps. On occasion, such pressure took the form of charges of incompetence, deliberate mismanagement, or blatant dishonesty against those captains, masters, and mates employed by the District. In a few cases, the charges extended to cover the district engineer himself.

A later American politician would one day define "pork barrel" as any public works project that benefitted the other fellow. This definition applies aptly to charges made periodically against the Vicksburg Engineers during this period. Self-seeking individuals flocked around Arkansas' congressional candidates in the early 1890's, for example, in anticipation of favors, rewards, or special appointments. When the victor later expressed support for recommendations of the Corps that benefitted others, disappointed supporters cried "foul" and "favoritism." Supporters of proposed engineering projects that were not funded called for congressional hearings where the charges of "pork barrel" were levied against the Engineers as well as the successful projects.

The twentieth century saw work boats bearing the Corps of Engineers' castle become quite familiar at the Vicksburg waterfront

District Engineer Willard endured more than one such attack upon himself and his employees with characteristic reserve; yet he was firm in his defense. "It is not out of place for me to state," the captain pointed out to his chief, "that during such times as I have had charge of works and the selection of men in 28 years of service, I have never appointed a relative or dismissed any man for personal or political reasons."

The records support Willard's defense. This long-term district engineer at Vicksburg was a terse and often gruff, penny-pinching, regulation-following administrator. But his actions and decisions were carefully weighed to avoid any justification for charges of wrong doing. In 1891, for example, Willard refused to suggest a site for the location of the proposed Rapides Bridge near Alexandria until plans were approved by Washington and all hearings held. If he selected a site in advance, Willard feared, some enterprising citizen might begin to buy up the recommended land, increase the expenses of the contractor, and expose the Engineers to unwarranted charges of favoritism or collusion.

Indeed, the records of the Vicksburg District for the four decades between 1888 and 1928 yield only one small incident of a deliberate misuse of position or materials by a Corps employee at Vicksburg. One (civilian) assistant engineer used government stationary to write personal letters to his nephew, his daughter, and his real estate broker.

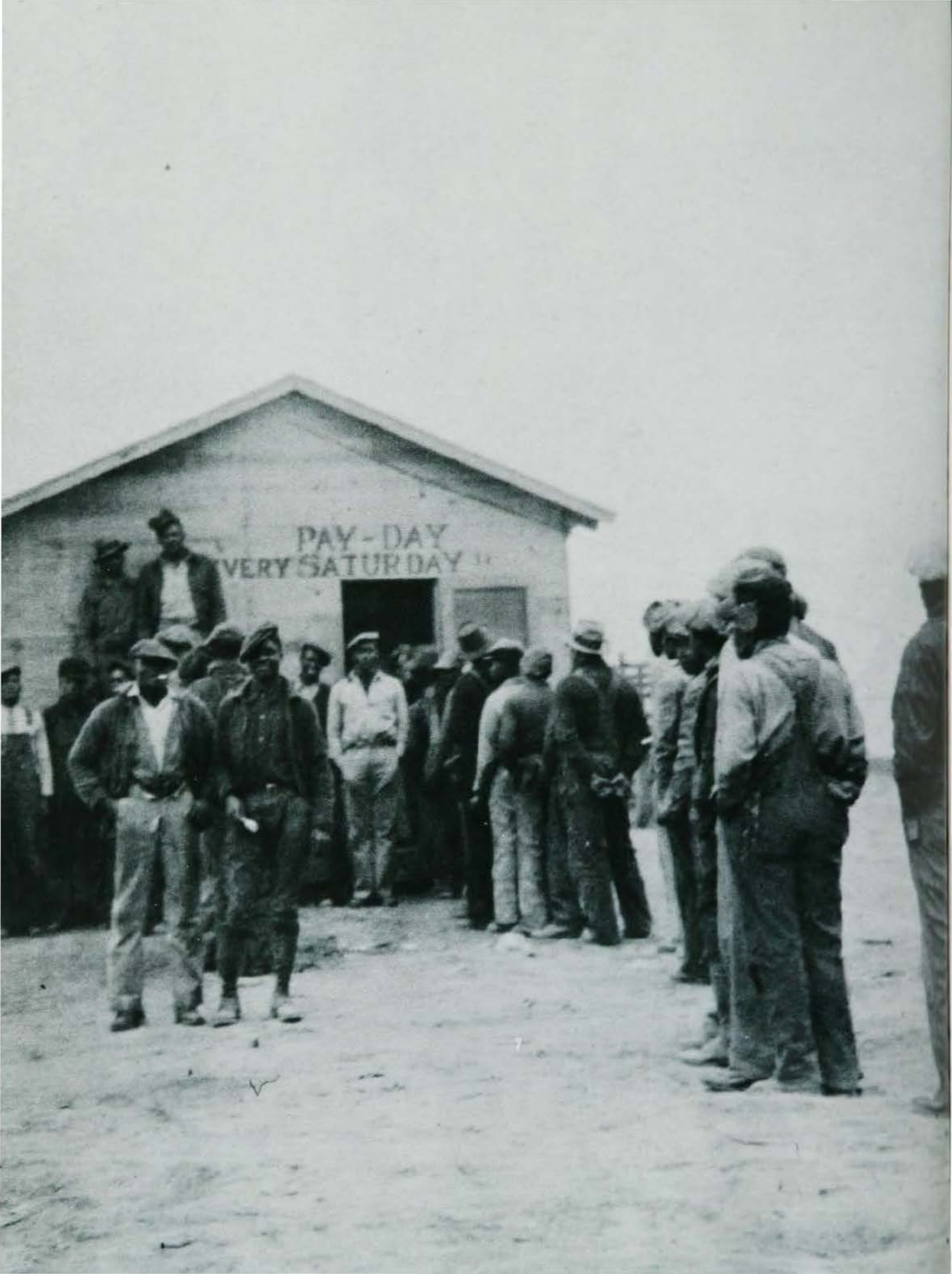
In summarizing the characteristics of the Army Engineers in general during this period, President William Taft informed Congress:

> *I know these Army Engineers very well. Doubtless you do, as you have met them in the District in which they were assigned. I venture to say that in your whole experience you have never met men of a higher standard of character, of a higher devotion to public duty, and of a greater skill in their profession....*

It was the golden era for Army Engineers in America. A rapidly expanding Nation needed help, and its needs were relatively simple. Such complex and often conflicting issues as ecology and recreation-resources, that would eventually be raised by a more affluent society, were yet utopian dreams that the hard-working American of this era had little time to ponder. Transportation and flood protection, by and large, were the only demands placed upon the Engineers by the people they served, and the directness of public need and the support which it offered the Engineers generated extensive technological advancement in these two areas.

The U. S. Army Fleet area at Vicksburg around 1910. The U. S. National Cemetery is at right

The dredge Barnard, *operated by the Mississippi River Commission, helped in making many of the postflood cutoffs in the Vicksburg District*


PAY - DAY
VERY SATURDAY

CHAPTER IV
FLOODS AND FLOOD CONTROLS

Bound by the chains
Of tilted green levees,
Sometimes you snap your bonds, and
surge on, strange and free—

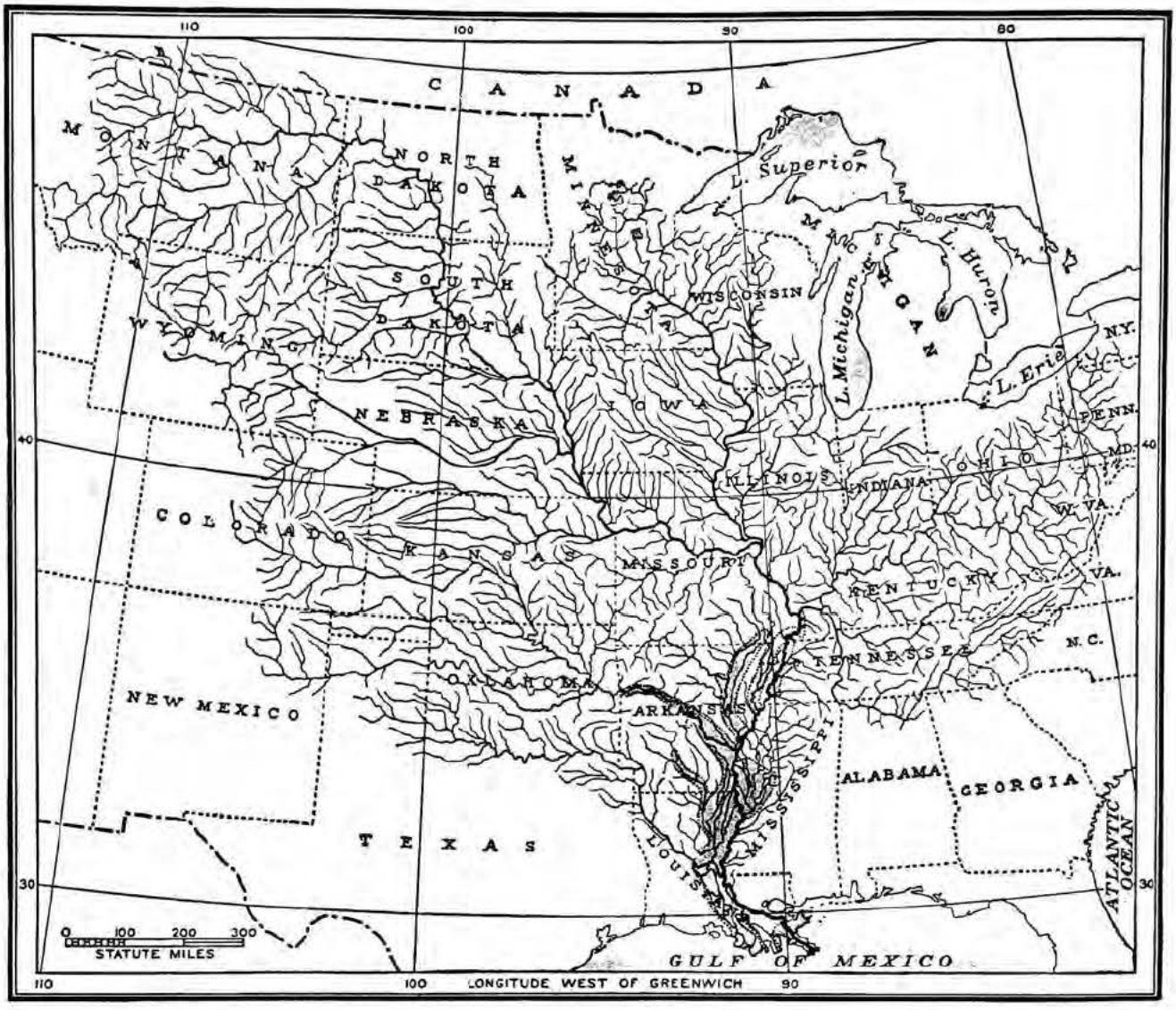
John Gould Fletcher

With irony in his ink, a sometime critic of the Corps once penned: "All good men are for flood control and against sin. But how to control floods and what is sin—aye, there's the rub." In two short sentences, the writer capsulized the quandary, the controversy, and the frustration experienced by Vicksburg Engineers for more than a half century.

Before the implementation of a comprehensive flood-control plan, much of the lower Mississippi Valley was covered by floodwaters on the average every 2.8 years. In 200 years of recorded history, over thirty *serious* floods were noted. Six of these (1785, 1844, 1903, 1913, 1922, and 1927) have been labelled "superfloods," and four out of these six were disasters with which the Vicksburg Engineers had to cope.

The enormity of the problem is obvious when the nature of the Mississippi River and its tributaries are analyzed. It has been said that the Mississippi changes sex at Cairo. In its upper reaches, the river is a gentle lady, flowing placidly along at a reasonable discharge of 450,000 cubic feet per second. When she meets the Missouri, another 900,000 cubic feet per second enters her channel; but, still, the lady is in control of herself.

At Cairo, the Mississippi encounters the Ohio River, with a discharge of 1.4 million cubic feet of water—and there the schizophrenic nature of the Mississippi becomes obvious. From that point, the river is very definitely masculine, "a broad brute of a waterway that demands respect and sometimes fear." As the river plummets southward, the Arkansas adds another 450,000 cubic feet and the Red 220,000. Too, there are smaller but sizable flood discharges into the Mississippi from the Yazoo, St. Francis, White, Tensas, and Ouachita Rivers.

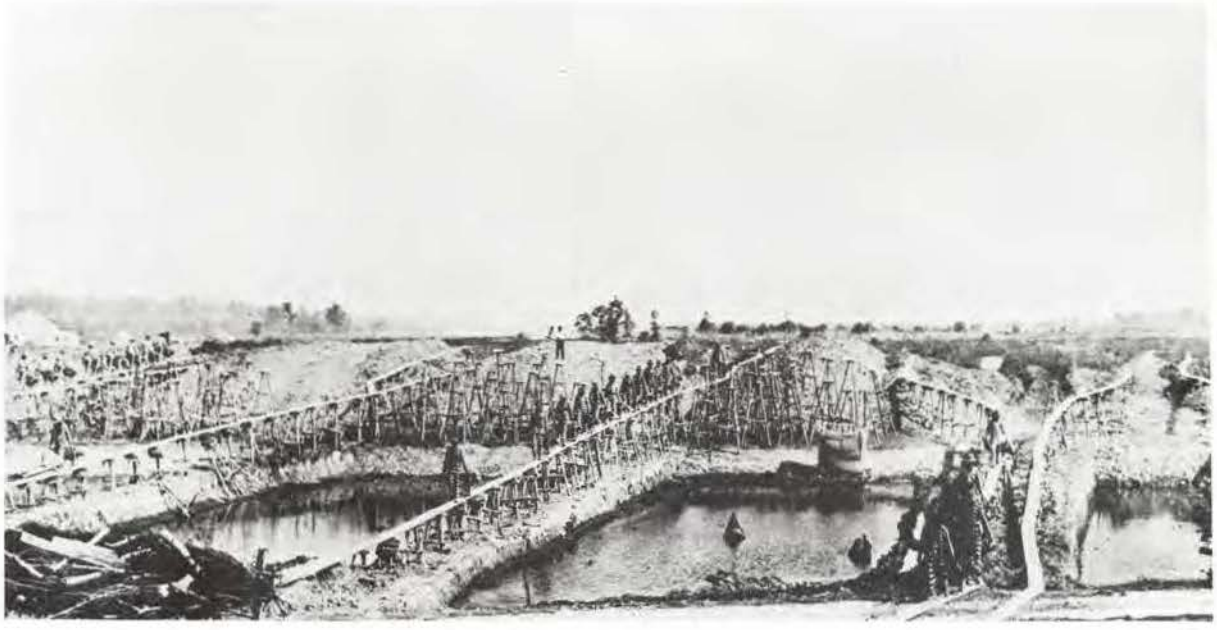


As long as the Mississippi stands at a low stage, the main channel is capable, usually, of handling the increased volume of the floodwaters of a tributary. But when two or more tributary floods are superimposed, the channel of the Mississippi proves to be too small and the excess waters flood the surrounding lands.

POLITICS AND CONTROVERSY

Such a situation occurred in 1882, the first major flood year experienced by Engineers in the Vicksburg region. Heavy rains fell upon the valleys of the Ohio and the upper Mississippi. As the flows of these two rivers collided and swelled southward, they encountered a rain-drenched lower valley. In the midst of the resulting disaster, Congress appropriated $100,000 on February 25 of that year, another $150,000 on March 21, and again on April 1 yet another $100,000. However, the total was appropriated only for the relief of those made destitute by the flood, not for preventive measures.

President Chester A. Arthur pleaded for more funds. Local levee organizations needed Federal help to repair crevasses caused by the flood. In Arthur's opinion, it was only prudent that Congress take steps toward the permanent improvement of navigation upon the river and toward the implementation of security measures for the valley. A second flood in 1883, followed by an even heavier



Building levee by wheelbarrow

deluge in 1884, required additional appropriations for relief. The wisdom of President Arthur's suggestion was even more apparent.

While the Nation debated the constitutionality of Federal involvement in flood-control works, flooding continued in the Mississippi Valley. In the years between 1890 and 1909, thirteen serious floods were recorded. An even more disastrous flood in 1912 left homeless over 10,000 people within the four Mississippi counties of Bolivar, Washington, Issaquena, and Sharkey alone. Rail traffic was suspended frequently throughout these periods. Productive plantations were abandoned as repeated inundations not only bankrupted their owners but ruined the land for cultivation by dumping immense deposits of sand and gravel on it.

In any history of flood control, these years must appear as an era of serious political controversy. Not only in Congress but also in a series of public forums throughout the Nation, protagonists and antagonists hotly debated the issues of responsibility and engineering principles. President after president spoke out loudly for Federal leadership in flood-control efforts, and Congress after Congress dallied. Every department of government, every corner of the private sector, had their favorite theories as to the "only" method of effective flood control.

When he accepted the nomination for the Presidency of the United States, James A. Garfield declared:

> *The wisdom of Congress should be invoked to devise some plan by which that great river shall cease to be a terror to those who dwell upon its banks, and by which its shipping may safely carry the industrial products of 25 million people.*

Twenty-five years later, President Theodore Roosevelt agreed: "We, the Nation, must build the levees and build them better and more scientifically than ever before." Yet, the Nation was slow to agree. The words "extravagance" and "inefficiency" were shouted frequently by critics. "Pork barrel," "higher taxes," and "sectional favoritism" also were strong verbal weapons.

Without a doubt, methodology was the most hotly contested issue of all. Historically, three basic methods existed by which

The tragic figures reflect the hardship of the turn-of-the century floods

rampaging waters might be controlled. Channels might be cleared to increase the capacity of a river and enable it to pass its waters from any given spot as fast as they arrive. Reservoirs might be constructed to hold the overflow until the channel was capable of assuming it. Or, levees might be built to confine all floodwaters within the bed of the river. Over the centuries, all of these methods had been employed with varying degrees of success by the world's leading civilizations.

Thousands of mules were used prior to time of the introduction of steam- and diesel-powered "monsters" to raise the grade of some levees and to build new ones

More recently, suggested methods as cutoffs and reforestation were added. Proponents of each theory cited examples of success on other bodies of water, yet their comparisons were hardly valid since most engineers agreed that the Mississippi was a river that defied all "acknowledged laws of hydronomics" and frequently disappointed "calculations based on recognized principles."

The controversy over methodology on the Mississippi was highlighted in 1852 by Charles Ellet, the civilian engineer employed by the War Department to survey the Mississippi and Ohio Rivers. In his report to Congress, Ellet advocated a comprehensive plan of levees, spillways, and reservoirs that was, in essence, ahead of its time. The report of the simultaneous survey conducted by A. A. Humphreys and H. L. Abbott treated such flood-control methods adversely, and their viewpoint prevailed for many years. In 1896, in answer to increased demands for adopting the reservoir system, the Senate Committee of Commerce initiated a 2-year study of the proposal and concluded that the enormous cost

Two dredges work to meet each other in early cutoff construction

of constructing and maintaining a system of reservoirs would far exceed the cost of leveeing the whole river basin. The committee stated explicitly that they could "discover no just or adequate relief" offered by reservoirs and concluded that the idea was "wholly impractical."

The committee's opinion was supported by leading engineers throughout the Nation, civilian as well as military. Continuing the debate in 1903, civil engineer B. F. Thomas argued that, even if one discounted the cost of establishing such a system, it was still out of the question. Reservoirs would require much expensive maintenance, since deposits would accumulate constantly. There would be the ever present danger of a reservoir breaking when full. Moreover, they would not always be empty or their water levels low enough at opportune moments. In short, Thomas viewed any such system as "unwise and inexpedient." As late as 1927, in the midst of the Nation's most disastrous flood, Secretary of Commerce Herbert Hoover discounted the value of reservoirs as a method of flood control:

> *As an aid to navigation this scheme is of great practical value, but as a means of controlling floods, it is negligible. This present flood, for instance,... would fill Lake Erie in two months time. You can get an idea from that of the impossibility of building reservoirs of sufficient capacity to take care of the excess water of the thirty-odd states drained by the Mississippi.*

Proponents of the cutoff theory were equally active in this period. Pointing out that nature, itself, caused frequent cutoffs at river bends, various engineers and members of the private sector felt that this natural phenomenon represented the best answer to flood-control problems. The tortuous bends of the Mississippi reduced the velocity of its currents. If these bends were straightened, the currents would flow faster and floodwaters would be discharged more rapidly.

On the surface this appeared a plausible theory. In practice, the logical conclusion did not always follow the premise. As Chief of Engineers General W. M. Black pointed out to a questioning Nation:

> *Experience has shown... that though such an effect is produced... it is but temporary, and the relief above is more than offset by increased injury below. In a cutoff which occurred from natural causes in 1884, the length of the river was reduced by 12-1/2 miles. The river at once began the work of restoring its former slope and by 1895 had regained a length of 5 miles, with a great destruction of valuable agricultural land.*

An even broader study of the effect of cutoffs indicated that available records from 1722 to 1908 noted 22 such natural cutoffs, with a reduction of 249 miles. Yet, the overall river distance from Cairo, Illinois, to the Gulf

William M. Black

remained almost equal to that recorded in the earliest documents.

A third popularly advocated method of flood control during this period was reforestation. Proponents of this method were considerably strengthened in their position by the reported results of an experiment conducted by The Forest Service in the White Mountains. When this study concluded that snow melted twice as fast on cleared land as it did when sheltered by trees, advocates of reforestation insisted this was sufficient proof that America's indiscriminate land clearing had caused the problem. Studies showing that forest trees evaporated 1/2 inch of water per day through their leaves intensified the demand for reforestation. Former Louisiana Governor, John M. Parker, vociferously blamed the more northern timber industry for Louisiana's problems.

This theory, too, was discounted by the Nation's leaders. The 1898 report of the Senate Commerce Committee also considered reforestation, along with the other proposed methods, and concluded:

> *Nothing in the evidence discloses the fact that the destruction of timber tends to cause or promote floods. It is the generally accepted opinion that it tends to rather diminish than to increase the rainfall.*

As late as 1913, the *Scientific American* continued its criticism of this theory by observing that there were on record many incidences in which torrential floodwaters had deluged regions covered with dense forests.

In reviewing the flood-control proposals of this era, one of America's foremost water management authorities concluded in 1927:

> *Half a century ago various persons, most of them without adequate information or training, began agitating for control of the Mississippi by...schemes...presented in such crude form as to destroy any possibility of successful execution...the Army Engineers entered into a hard fight for "levees only," and they won.*

The Engineer Corps, in this period, had considerable support in their advocacy of levees as the only practical means of flood prevention. Supporters of the "levees only" theory included the Nation's leaders and her general populace, as well as civil engineers. Levees were monumental, ever present symbols of flood protection, behind which the valley's residents felt secure—until a flood crested that long, green earthen wall. Then the populace clamored for higher levees. There was considerable truth in the quip of a later writer who observed:

> *Along the lower Mississippi it was not quite respectable to advocate any means of flood control other than levees. The levees, like the Democratic Party and quinine, were a known specific for a prevailing ill, and to be treated with equal veneration.*

Caulks Neck cutoff south of Rosedale, Mississippi, in 1937. After dredges had cut to within a reasonable distance (top), dynamite was used to open the new channel (center) which the Mississippi River was quick to adopt (bottom)

Prime farmland, previously unusable in times of high water, can now be used during the worst of floods to produce food and fiber

The dike or levee system of flood control has enjoyed the advantage of being the world's oldest. As early as the Twelfth Dynasty of Egypt, pharaohs were building levees along the Nile to prevent the overflow if its Delta. The Babylonians, Phoenicians, and Romans erected similar works. Nearly every river of Europe and Asia had long been guarded by man-made walls. America's engineers were familiar with the levee principle and considered it the most reliable, the most proven.

LEVEES, LEVEE BOARDS, AND THE ARMY ENGINEERS

The Corps of Engineers entered levee construction work in 1882. Spurred to action by a disastrous flood, Congress appropriated over $4 million for waterways improvement in the Mississippi Valley and permitted the Engineers a certain amount of discretion in the use of these funds for levee building. Basically, such funds were to be applied only when the construction of a levee would benefit navigation. However, the dual value of the levee system pointed out by Humphreys and Abbott two decades earlier (i.e. navigation improvement as well as flood protection) allowed the Engineers considerable latitude in the use of these funds.

From 1882 to 1917, the United States Engineers provided considerable assistance to local levee boards in their construction of levee protection works. Out of a chaotic conglomeration of piecemeal projects, a considerable degree of cohesion and standardization evolved. The system by which each locality controlled its own levees had proven ineffective. A great variation existed in the height and strength of the levees along the lower Mississippi and its major tributaries, as each state-chartered levee board set its own standards. Negligence, poor planning, petty rivalry, and fraud plagued this levee construction system in some areas to the

detriment of all. An insufficient levee in one locality that was overtopped or crevassed under the pressure of floodwaters often deluged neighbors. Mississippi Valley levees were an earthen chain no stronger than its weakest link. Through the establishment of uniform standards alone, the Mississippi River Commission contributed significantly to the protection of the lower valley.

The Commission controlled Corps participation in levee building along the Mississippi River. But in the backcountry of Mississippi, Louisiana, and Arkansas, there were numerous streams on which state engineers and local citizens were attempting to build protective works. All were eager and appreciative when the Engineers of the Vicksburg District were authorized to offer their assistance.

Early experimental concrete slab mattress used prior to present methods

Vicksburg Engineers received their first appropriation for levee work in 1892. The Red River Survey had been completed, and Captain Willard's report on its results outlined a comprehensive seven-point plan for the permanent improvement of that river, in which he emphasized the necessity of constructing a "substantial system of levees ... either alone or in conjunction with the riparian States." Upon his recommendation, Congress appropriated $57,000 for that purpose.

Working in conjunction with the State of Louisiana, the Caddo, Bossier, and Red River-Atchafalaya-Bayou Boeuf Levee Boards, the United States Engineers assisted in the construction of 75 miles of new levee along Red River. With great pleasure, Willard reported:

> *The most cordial and harmonious relations have subsisted between the local engineers and the State engineers and levee boards, and that a large amount of continuous fine levee work has been made possible through such cooperation.*

The levees constructed under Willard's supervision were built to a net grade of 3 feet above the flood of 1892, the greatest Red River flood on record. Yet, the Vicksburg Engineer remained uneasy. "I am of the opinion that a higher grade should be required," Willard reported to the Chief of Engineers. "The high-water line is not uniform in slope.... I should urge making the net grade 5 feet above highest water recorded to make the levee system safe and to allow for deterioration."

With each succeeding year, the Red River leveeing activities of the Vicksburg District continued. By 1900 the United States had

One of two giant cranes which made up a levee-raising "tower machine"

added over 1 million cubic yards of levee on the Louisiana portion of that waterway at a cost of $174,000. The state and local levee boards, continuing to shoulder the bulk of responsibilities as Congress insisted, constructed almost 10 million cubic yards with an outlay of $1.3 million.

The construction of Red River levees in Arkansas did not parallel the progress made downriver in Louisiana. Arkansas residents began petitioning the Vicksburg Engineers, about 1897, for the construction of levee works, but their requests were not met favorably by Willard. Congress still restricted his activities to the improvement of navigation only, and Willard—a conscientious adherent to the strict letter of the law—did not feel that navigation of the Arkansas portion of the river was extensive enough to justify the expenditure of limited funds for levees there.

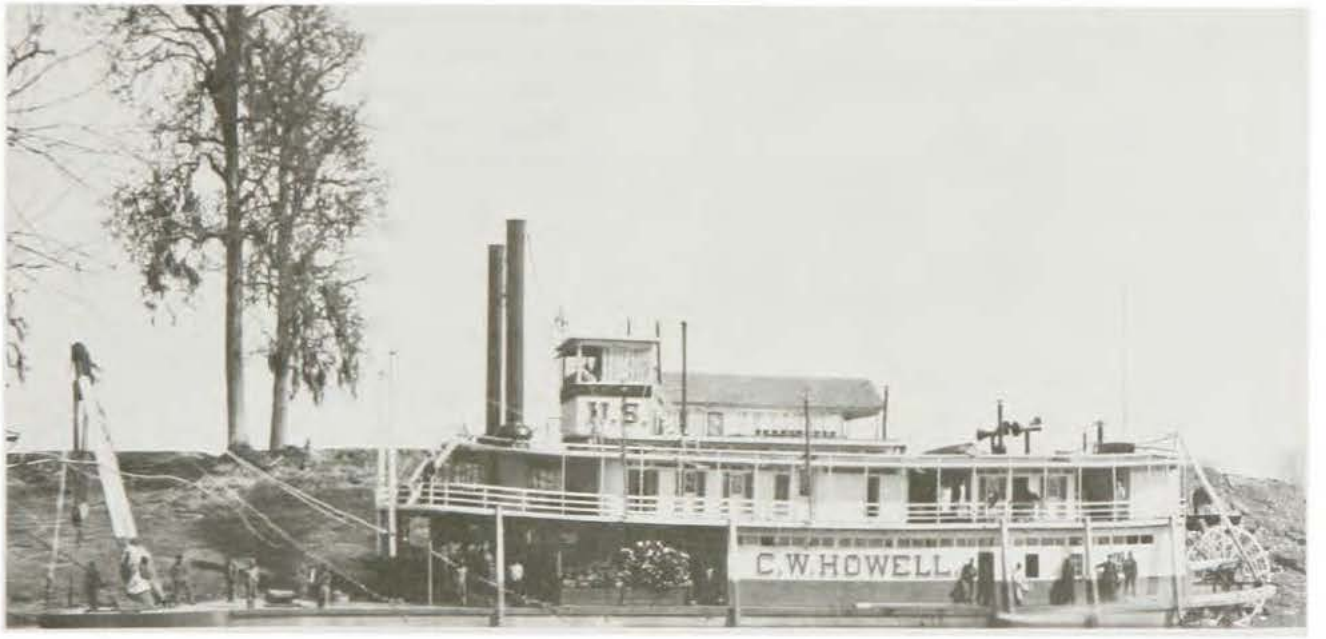
Moreover, Willard noted that the residents of that area had lagged in providing their own levees for flood protection. In fact, as the flooding in Arkansas washed backwaters into upper Louisiana, the lower state had been compelled to erect levees beyond her borders as the only means of protecting her residents in the northwestern part of the state. It was becoming increasingly obvious from these incidents that the levee system must be controlled by an authority capable of crossing all political divisions and geographical boundaries.

A similar demand for levees also was made, beginning in 1896, by certain residents of Louisiana who lived along the Ouachita. The state engineers were beginning to work in this region, and Willard anticipated that the Federal government eventually would be called upon to do considerable levee work along that waterway. In the meanwhile, handicapped by his restriction to build levees only for the improvement of navigation, Willard could not justify the construction of levees on that stream.

Federal levee work within Mississippi was conducted primarily by the Mississippi River Commission. Through very generous allotments, the Federal government had subsidized better than half of the expansion program in the Yazoo-Mississippi Basin between 1897 and 1903 and continued to subsidize the work after that date. By 1905 it was generally believed that levee construction in that area was almost complete, but heavy flooding the following year regenerated demands for higher levees throughout the Mississippi Delta.

The Vicksburg District already was engaged in extensive improvement of the Big Sunflower, a tributary of the Yazoo, and by

Engineer offices were scattered throughout this Vicksburg city block from the 1890's (in the building on the right end of the street) to the 1940's (in the Morrissey Building, not shown)



The snagboat C. W. Howell *at work on the Yazoo*

The new concept of dual cableway machines greatly reduced the cost of levee building, making the earthen walls better values than ever before

1907 was conducting considerable dredging work on that river. To assist the local levee board in its flood-control efforts, the Vicksburg Engineers deposited the dredged material on the leveed banks, thereby raising those banks under the congressionally approved catch-all category of "contraction works." By 1922 the District had expended $55,000 on dredging and "contracting the banks" of that river.

Elsewhere in the Mississippi Valley, the chain of levees continued to grow in length and height. Drainage improvements throughout the basin created new levels of runoff that in turn created new flood peaks, and each new high level mark recorded on the Engineers' river gages required the enlargement of existing levees. By 1912 the total length of the levee was 1500 miles—the length of the Great Wall of China. The total area protected was approximately 26,600 square miles—an area larger than the combined expanse of Massachusetts, Connecticut, Rhode Island, Maryland, and Delaware.

The rapidly increasing height and breadth of the Valley's levees after the turn of the century presented yet another problem. The man-mule-shovel-wheelbarrow method of levee construction was hopelessly obsolete. It simply could not produce barriers of sufficient size and strength, and the continued use of this outmoded technology resulted in skyrocketing costs. When the average reached a peak of $25.80 per cubic yard in 1913, the District began an intensive program of study and experimentation to develop an adequate inventory of levee-building machinery.

Other Districts, in this period, adapted steam shovels to dragline excavators. Along the Gulf Coast waterways of the New Orleans District, for example, these machines proved quite effective. Above the mouth of Red River, however, a dragline with even the longest boom available was unsuitable. The construction of existing levees had used up already all allowable dirt available from borrow pits within reach of the boom.

The answer to the problem was found in an adaptation of commercial cableways. By rigging a sturdy cable between two towers (one erected at the levee and the other at the site of the distant borrow pit) the dirt could be transferred without the necessity and added expense of dump wagons. By 1915 the cost of levee-building within the Vicksburg District had dropped to 15¢ per cubic yard.

Despite the improved quality of the levees, the system still was not accepted as the "ultimate weapon" against floods. Its backers were elated by the statistics they compiled; but, on the other hand, advocates of other modes of flood protection used those same statistics to prove the extent to which the levee system was failing.

In 1882, before the Corps of Engineers began a levee-building program, 284 crevasses in the existing levees were recorded; by 1897

Floodwaters approach the city front at Vicksburg before construction of its first seawall

this number had been reduced to 43. The superflood of 1903 made only 6 breaks in the entire levee system, and the flood of 1907 brought only one. John M. Parker of New Orleans was quick to point out that the reduced number of crevasses had resulted in a "fabulous" increase in capital investment in the Mississippi Valley. Low-lying backcountry had previously been worthless; now towns and cities and railroads were springing up throughout many such regions. "All of this affords evidence of the strongest possible conviction on the part of the people," Parker declared, "that the time is sure to come when they will have absolute protection from the floods of the river."

Yet, as the number of levee breaks continued to decline, the incidences of serious flooding increased. As more and more levees confined the floodwaters to the channels of the Mississippi and its major tributaries, the crests of these floods swelled higher and exerted a stronger force on the confining dikes. When a crevass did occur, the savage currents produced unparalleled destruction.

The devastating flood in 1912 brought widespread agitation, and those who had expressed such confidence in the levee system were forced to evaluate critically their position. Clearly the old system in which flood protection works were parcelled between six diverse sectors (district levee boards, county or parish officials, state officials, Federal engineers, railroad officials, and individual planters) was not working. Hearings held by the Congressional Commerce Committee in 1912 consistently emphasized the need for Federal assumption of all flood-control activities to relieve the poor who suffered most.

Again, Louisiana's John Parker appeared before the committee, speaking on behalf on the "many thousand small farmers who do not own their land, but who have, by dent of hard work and industry, and frugality, accumulated the necessary equipment in farming implements, teams, livestock, etc."

The recent flood had claimed 96 mules on the Parker plantation alone, in addition to other livestock and farm equipment. Most of this property belonged to his poor sharecroppers.

Similarly, the 1912 platforms of the Democratic, Republican, and Progressive parties all advocated increased national participation in flood-control activities throughout the Mississippi River Basin. President William H. Taft pushed for realization of these platform goals in his address before the Rivers and Harbors Committee late that year. Taft firmly believed that the general welfare provisions of the constitution provided all the legal basis necessary to prevent the danger of floods in the Mississippi River Valley, and he called for an appropriation of from $40 to $50 million to improve the levee system to a point that flood damage would be a thing of the past.

A national propaganda campaign was begun by those flood-control interests who feared that riparian states soon would give up their fight. In pushing for Federal takeover of the entire flood-control program, supporters were quick to point out that the latest Rivers and Harbors Bill had appropriated only $7 or $8 million for the Mississippi River. Yet a greater amount already had been spent for the construction of each Navy dreadnaught, and the advancement of aeronautics and naval war science would soon render these dreadnaughts obsolete. The *Scientific American* editorialized that its "enormously increased volume" of mail on the subject "proves that the magnitude and pressing importance of this question is appreciated not only by residents of the Mississippi Valley, but increasingly by the Nation at large."

FLOOD CONTROL LEGISLATION

The years 1915 and 1916 brought renewed flooding and, at long last, a receptive Congress. Under the leadership of a Louisiana senator and a Mississippi representative, Joseph Ransdell and Benjamin G. Humphreys, there was developed in 1916 and 1917 a flood bill that represented one of the most important developments in national internal policy. With the passage of the Ransdell-Humphreys Flood Control Act in early 1917, the Federal government irrevocably committed itself to the prevention and control of floods. Following Taft's suggestion, the new law rested on the welfare clause of the Constitution that had been used for so many decades as the bulwark of defense by those who opposed Federal assistance to the valley.

In essence, the Flood Control Act of 1917 made two major provisions that affected the Mississippi River Valley: (1) A sum of $45 million was appropriated for flood-control work, to be expended by the Mississippi River Commission at the rate of $10 million per year; (2) Local interests were required to contribute at least half the cost of all flood-prevention works in their area (a decrease from the previously required two-thirds), and to provide the right-of-way for all levees.

The Ransdell-Humphreys Act was passed on the eve of the Nation's entry in World War I. Amid the problems and demands that resulted, the issue of flood control was eclipsed. With the special funds authorized by Congress, the Mississippi River Commission initiated and/or completed a number of worthwhile projects. District engineers, however, found that their decreasing appropriations left no

funds available to help local levee boards and state engineers.

At Vicksburg, Major John R. Slattery assisted the Long Prairie Levee District in Arkansas with the closure of a crevasse along Red River in Lafayette County. After the construction of 40,000 cubic yards of embankment, however, Slattery was left only a small balance of $1400 in his levee fund. When the next congressional appropriations made no addition to this fund and made insufficient appropriations for general maintenance work, the new district engineer, civilian Thomas C. Thomas, requested permission to use the balance of the levee funds for general maintenance. A shortage of maintenance funds continued in the Vicksburg District for several years and levee work received no funding at all.

In 1922 the lower Mississippi Valley was again deluged by floodwaters. Again, critics loudly assailed the levee system. "Even those who heartily endorsed the system now realize that it has been a monumental failure," one antagonist wrote, "other means must be adopted or we will face ruin. Within the Mississippi, Yazoo, and Red River Basins, however, that feeling was not universal.

The high-water fight in the Yazoo-Mississippi Basin was an expensive one that year, but the levees held. No crevasse occurred in the east bank levee from Memphis to Vicksburg or in the levees of the Yazoo, despite the fact that flood crests reached the all-time high of recorded floods to that date. Similarly, along the Red River, which long had overflowed its banks in high water, the damage was minimal. Major J. A. O'Connor, Vicksburg's district engineer, reported in 1922

John R. Slattery

J. A. O'Connor

and 1923 that the flood level of the Red River actually was lowered by the improvement work of his engineers and the levee boards.

Indeed, the successful high-water fight of 1922 brought increased confidence in the levee system within the Vicksburg District. The Nation was in the throes of an era of expansionism, and northern capital flowed heavily into the Mississippi Delta. Many levee engineers began to believe that this District had, at last, established the perfect flood-control system and that their work soon would be reduced to a matter of maintenance.

The steamer Hallette *unloads a shipment of cotton at the Vicksburg riverfront following World War I*

R. P. Howell

Yet, prompted by disaster elsewhere in the valley, Congress passed a second flood-control act. The annual appropriations provided by the Act of 1917 had been expended; the 1922 act extended those annual appropriations of $10 million for an additional 6 years. Recognizing the impoverished condition of the more heavily deluged areas, Congress reduced the matching funds required of local interests to a minimum of one-third total costs rather than the one-half exacted of them for the past 5 years. Local interestswere still required to furnish the levee right-of-way and provide maintenance for the completed works.

Reflecting its growing concern with flood protection, Congress also directed the Vicksburg Engineers to conduct a preliminary examination of two Mississippi streams where levee protection was considered less than adequate by some interests. The district engineer, Major R. P. Howell, promptly directed the study of the Tallahatchie and Coldwater, but his report was unfavorable. Howell did not feel that Federal participation in levee protection works on these two, small rivers would be advisable, but he did feel that the character of these two streams should be reassessed as a part of a proposed overall plan for improving the Yazoo Basin.

Again, in 1924, Congress directed a second

Concrete mat sinking plant in operation at Caulks Neck, Arkansas, October 1926

John C. H. Lee

preliminary examination within the Vicksburg District in response to demands made by Arkansas residents along Red River. This area had long suffered heavier flood damage than was experienced along the Red in Louisiana, primarily due to the decreased efforts exerted by state and local interests within Arkansas.

In reporting the results of his preliminary examination of the Red within that state, Major Howell recommended a follow-up survey of the river to determine the best means of flood control, but he also suggested that it be conducted in conjunction with a survey of the lower river as well. Howell's recommendation was approved by a congressional act in March 1925. Over the next 3 years, the Vicksburg Engineers would give that waterway the most comprehensive analysis it yet had received.

THE FLOOD OF 1927

The Red River survey was not yet completed when the entire Mississippi Valley suffered the most disastrous flood in its history. The crisis was not unexpected. Major John C. H. Lee had arrived at Vicksburg in the summer of 1926 as the new district engineer for both the Vicksburg District and the Third District of the Mississippi River Commission. Oldtimers within the organization immediately warned him of the high-water fights he would experience and advised him that flood control would be the heaviest responsibility that he would face.

Lee had been in the District only 3 months when he noticed a sudden rise in the Mississippi River gage at Vicksburg—40 feet, and it was only October. Lee immediately pored over the history of this gage and found that in the 54 years of its recorded history, it had reached 30 feet in October only six times, and each spring there was a high-water emergency. T. C. Thomas, the District's veteran civilian engineer, dryly advised Lee: "Phenomena which follow the same sequence six times out of six without fail can be accepted as a reasonably safe rule to observe." With Thomas' help, Lee began to mobilize the District.

As borrow pits and willow bars began to flood and fieldwork was suspended, the Vicksburg District began to formulate its emergency plan. Lists were made of the levees that were considered to be inadequate. Levee seepage, sand boils, and slides all were taken into consideration. Estimates were made of the various expenses that would be incurred and arrangements were made in advance with the levee boards for a division of financial responsibilities.

The human element was anticipated especially. Public panic not only would make the work more difficult but would create labor problems as well. Public relations work began immediately to foster confidence in their organization. Lee soon would have cause to be especially grateful that such harmonious relations existed between the Army Engineers and the levee boards.

January 1927 brought minor flooding;

Transportation in the Mississippi Delta was brought to a halt as rushing waters covered roads, washed away bridges, and flooded homes and railroad offices

Seaplanes ordered by Major John Lee waited at the District's base on U. S. Highway 61 to be called out all hours for rescue and reconnaissance

February brought even more. The Mississippi's crests fell slightly in March but rises in the Ohio, Missouri, and Tennessee Rivers late that month made it apparent that a crisis was inevitable. On April 1 equipment, forces, and emergency supplies were dispatched to predetermined stations and patrols of the levees began.

Within the Vicksburg District, there were 420 miles of levees which Major Lee had to inspect. The local Agricultural Department Experiment Station volunteered the use of its aircraft to facilitate the inspections; but land planes were provided. Lee soon found that unless he could alight and take off from water, he could not get close to the various field headquarters. An Army amphibian was requested; it wrecked en route. Lee then asked for Navy seaplanes, and they arrived promptly—not only small U-O's with Wright whirlwind motors for his inspection trips, but bombers as well which could be used in the Corps' traditional evacuation and flood-relief work. These large airships proved to be of immense service in transporting passengers and emergency supplies. Then, behind the bombers, came photo ships that enabled the District to record the overflow limits.

In retrospect, Lee later commented: "We know now we could not have won." Even if he and his fellow floodfighters had held all of their levee lines, the water still would have risen 9 feet above the crown of the levee. "But," Lee continued, "our fighters did not know.... They only tried their best...." Then came the night of April 20-21, the worst the District experienced. Major Lee reported:

> *We were truly "catching hell and high water." The old Arkansas was raging out with the White.... The Mississippi was still rising way above Memphis. So many breaks had occurred on the upper Arkansas that all records and predictions up there proved useless. It was raining all over the District. From dark until dawn came calls for help.*

At 7:15 on the morning of April 21, the Mississippi River levee itself broke at Mound Landing, Mississippi—between Benoit and Greenville. James Hand, Jr., of Rolling Fork, a veteran floodfighter, was on the scene when the

crevasse occurred. Hand later described the terror he witnessed:

> *Daybreak was late in coming.... The water lapped at the top of the levee, inching upward. Then it happened. Huge chunks of the earthen wall gave way slowly at first, then more rapidly as water poured through the break. Within minutes there was a huge gap, and the raging floodwaters spilled mercilessly over the already soaked land.*

Area planters already had evacuated many of the tenants from their lowland houses, and their livestock as well, but many residents remained within area communities. The nearby city of Greenville, with 15,000 inhabitants, was flooded completely. Refugees were evacuated to the crests of the levees that remained, and then taken to the concentration camps manned by the Red Cross.

Crevasses continued throughout the levee system. Before night fell that April 21, two more breaks occurred within the District, both on Arkansas levees. Engineers and civilians alike had made valiant efforts at both points, but stood little chance in the raging storm which not only increased the level of the waters but also blew the river's currents in vicious gusts.

At South Bend, the front had already been held for 10 turbulent days. The levee was almost entirely gone. Only a hastily built-up sack levee, just behind the gaping one, held the

Greenville, Mississippi, the "Queen City of the Delta," took the full force of the first levee break at Mound Landing

Arkansas City, Ark.,
1 May 1927

Rolling Fork, Miss.,
2 May 1927

Vicksburg, Miss.,
3 May 1927

Convict labor was brought in to raise emergency mudboxes. As more refugees left the lowlands, the available work force dwindled

floodwaters from the Arkansas land. Lee's South Bend laborers consisted of whites and blacks (both draftees and volunteers) and National Guardsmen and convicts. All worked side by side. Sand boils added to their difficulties. "The men in charge worked in water until they could no longer wear shoes over their swollen blackened feet," Lee later wrote, "...but they did not stop." In the course of the fight, one Corps employee lost his life, Captain W. C. Porterfield, chief engineer of the U. S. Grader 1014.

The worst problems, however, were caused by the crevasse at Mound Landing. Floodwaters surged over the fields and lower woodlands of the Mississippi Delta and forced their way back into the Mississippi at the end of the Delta near Vicksburg. The flood level rose even higher. Louisiana's levees were topped. A weak spot at Cabin Teele gave way, and the Tensas Basin was deluged. No lives were lost due to Lee's anticipation of the break and his timely evacuation of the area, but houses, lands, and buildings were devastated.

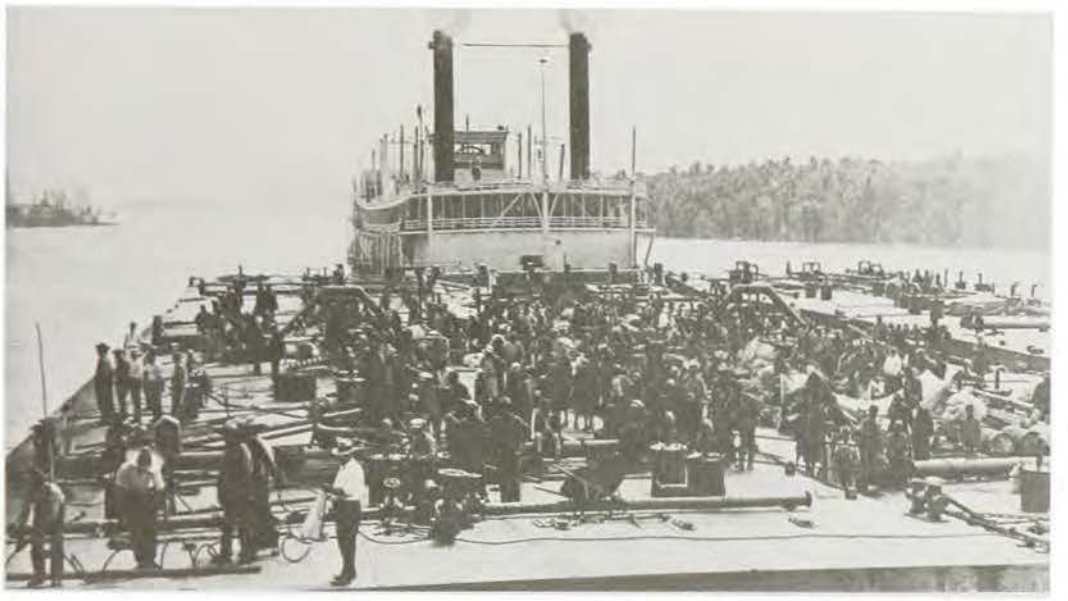
There was little that the Vicksburg Engineers could do to ease the fury of the torrent that poured through these crevasses. Not until the strength of the attack expended itself could protective or repair work resume. In the meantime, relief work was the primary concern of all. Thousands were homeless, stranded in trees, on the tops of the levees, on floating housetops, or anything else that would drift on the crest of the currents.

In the evacuation effort, Major Lee commandeered every type of craft and equipment possible—surf boats from the U. S. Coast Guard, Navy seaplanes with their mother ships and radio equipment. Standard Oil donated the use of their towboats and barges. There was hardly any type of seacraft that could not be used in the vast ocean that covered fields, roads, and homes. Paddle-wheeled riverboats churned right over plantations seeded with cotton only weeks before. One paddled down the main street of Rolling Fork and docked at the depot.

Utilizing reconnaissance planes to locate stranded refugees and rescue boats to take them to safety, Major Lee and his organization filled the Red Cross camps with evacuees, their animals, and their possessions. It was with some seriousness in his jest that one National Guardsman reported: "The farmers saved their shotguns and dawgs [sic] and most of their kids!"

At Greenville, hundreds of families huddled on the secondary levee that surrounded the town. It was a scene that, in the words of one Corps official, "beggared description." Hundreds of evacuees shivered in their tents or crude shelters. Indeed, some had no shelter at all. Long lines filed past the "savory soup kitchens for their doles...cows and horses and dogs of every description wandered up and down...." In their midst stood furniture—"every kind of treasured junk imaginable."

Yet, amid this chaos, a surprising degree



Rescue boats, like the giant Sprague, *moved from town to town or from one marooned group to another loading and hauling people, furniture, and livestock to safety*

of efficiency was achieved. Evacuees were vaccinated immediately to protect them against the epidemics of whooping cough, typhoid fever, measles, and mumps that swept the camps. At Greenville, officials sought to establish a control system by dividing new evacuees according to their voting precincts, and each new arrival had to be vaccinated in the medical tent of his own precinct. One confused woman appeared at the wrong station and was tersely told: "You don't belong here. You've got to be vaccinated in your precinct." Puzzled, she asked: "But why can't I get vaccinated in my arm like everyone else?"

Nurses and hospital tents were provided by the Red Cross in all of the larger refugee camps

The refugees tent city in the National Military Park at Vicksburg

Within every camp there was an isolation tent, a first aid station, a venereal disease tent, and yet another for maternity patients—five babies were born on the Greenville levee on the one night of April 23-24. Then, too, there were separate camps for whites and blacks. At Vicksburg, the emergency quarters that the Red Cross set up in the National Cemetery had three divisions: the usual two camps for white and black and a third for 300 Mexican farm workers who were not accepted by either of the other races. There, on May 5, the Mexicans celebrated their Independence Day, "making speeches to each other and dancing to a borrowed piano."

The maintenance of order under such emergency conditions was no easy task. As Major Lee explained it: "To hold men faithfully to their duty for weeks of this work meant a carefully organized system, regularly inspected, faithfully supervised." Some degree of confusion and conflict was inevitable, primarily—or at least in Lee's opinion—because of the lack of authoritative organization and a system of rank among the emergency workers. His point was well illustrated with the story of two laborers. One admonished the other, "Boy, better you do dat dis here way, like the Capt'in say." "How come," the other argued. "I got my orders from de Sargunt, better you do as de Sargunt say, he's de regular recrootin' Sargunt and de Capt'in, well Mr. Harry, he's only a home-made Capt'in."

The backbone of the volunteer relief workers, in Lee's opinion, was Charles Williams of the little Mississippi River town of Benoit. Williams had organized his plantation foremen in anticipation of the crisis and had rigorously trained them. After the nearby Mound Landing break occurred, Williams became "the life of the relief organization. No job was too difficult; no situation too grave. He met everything with a smile."

In the course of the evacuation process, a group of boatmen—who in sunnier days claimed the bootlegging profession—decided that they really did not care for their new employment and threatened to leave. Williams appealed to their pride as well as their consciences and reminded them that they were more skilled in boating through the woodlands and swamps than anyone else available. When this tactic failed, he tried a more direct approach: "See here, you fellows,...your best

The "levee city" at Greenville. Several children were born on the levee, one of them named Flood Rolls, because he rolled in with the water

customers are some of the leading people of the Delta. They are counting on you. Brace up now, and take a real noble attitude in this matter." The practical approach worked.

As the refugees throughout the Mississippi Delta were resettled into the camps, Major Lee shuttled from Greenville to Vicksburg to the Arkansas River to Delhi, Louisiana. No corner of his District was left unsupervised. An engineer officer from the Mississippi River Commission arrived at Delhi on May 6 to find the refugee camp there cut off from rail service on all sides. Delhi's evacuees were entirely dependent upon the already overworked boats and planes to provide their needs. "This is Lee's area," the office reported, "and is being well cared for."

By May 17, Lee and his Engineers had begun the monumental task of repairing the damaged levees. His economical management of the high-water fight had left him with sufficient funds to make surveys of the crevasses—hydrographic surveys, since the breaks still were covered with floodwater. Plans were mapped out for closing these gaps at the earliest possible date. By the time that the inspection force of the Mississippi River Commission had passed through his District and were ready to accept his recommendations, Lee's Engineers had their surveys completed and their plans well formulated. Moreover, the fiscal condition of the District office was in such good shape that Major Lee was able to transfer a portion of his funds to areas that had suffered more heavily.

By July the waters had receded to the point that the actual work of construction could begin. Temporary protection levees were thrown up in front of the gaps to prevent flooding of their new works before these were completed. Four serious return rises on the Arkansas River proved the wisdom of this preventive measure. When civilian contractors placed unreasonably high bids on the work of closing the gaps, the Vicksburg Engineers borrowed the equipment needed and filled the lines themselves. One hard-driving employee, Eric Dye, put up a million yards of levee alone at Mound Landing—half of the total needed to close that gap.

By early 1928, Major Lee had reported that the levee lines within his District were in better condition than ever before. His Engineers had compiled new and more accurate District maps that would simplify the

next flood fight and had made a thorough transportation study of the District that recorded every land and water route, as well as landing facilities for aircraft. "We do not want any more floods," Lee pointed out, "but we know we must be ready to fight them until the comprehensive program for flood control is completed."

The flood sufferers themselves were not nearly so optimistic. Mark Twain once had avowed that "10,000 river commissions," backed by "all the mints of the world," would never curb the Mississippi, or confine it, or "bar its path with an obstruction" that it would not chew up and spit at them. There were many valley residents ready to agree with him in 1927.

By the time this superflood occurred, the Mississippi River Commission and the various levee boards had built more than 1324 miles of dirt embankments at a cost of $238 million. Their total length was more than 300 miles greater than the length of the lower Mississippi itself. In its annual report of 1926, the Mississippi River Commission had even ventured to predict that present flood-control works were capable of preventing the disastrous effects of floods.

Yet, the flood of 1927 inundated 26,000 square miles of land. The entire west bank of the Mississippi, from a point opposite Cairo to a point facing Natchez, had been overflowed. Northern Louisiana, for example, had been "turned into an inland sea from 250 to 300 miles long and from 50 to 100 miles wide." Property damages throughout the valley approximated $236 million—almost as much as the entire sum spent on the construction of those levees. Some 214 lives were lost and 637,000 people were driven from their homes. Half of the wildlife in the valley perished in the deluge.

1927 FLOOD LOSSES
IN THE VICKSBURG DISTRICT
(millions of dollars)

Tangible property	$ 14.5
Crops	50.0
Livestock, etc.	15.0
Suspension of business	10.0
Protective work, etc.	15.0
Total	$104.5

Vast numbers of people had begun to ask: "Is it *possible* to control the Mississippi River?" Many valley residents who had stoicly refused Federal relief after the flood of 1922 now had lost hope. In conference with Secretary Hoover, who was charged with the overall relief responsibility in this disaster, one Natchez resident despaired:

> *We have done our best,...but there is much still to be done; there is the future still to be faced, and we are tired. The flood threatens us with exhaustion and despair. We must have hope as well as physical and financial assistance. If only you could give us that hope!... Some word, some message of assurance that we can send out to our people...some definite assurance that this thing will never happen again.*

Hoover, himself a successful businessman and engineer, firmly believed that it was possible to check the worst rampages of the Mississippi. "If we can take care of a normal flood, we also can take care of a superflood.... It's merely a matter of financing." Hoover also assured the sufferers that they had his fullest

Secretaries Hoover and Davis visited the youngsters in camp at Natchez, Mississippi

support. A program would be devised, and he would fight for more Federal financing to ease the burden of those in the lower Mississippi Valley. "It isn't fair, is it," the Secretary commiserated, "to ask the man who lives at the end of the sewer to pay for the whole sewer?"

Secretary Hoover also believed that the "levees only" system had succeeded, as far as it was applied. But these sentiments of his found less public support. Even within the Mississippi River Commission and the Engineer Department at large, there was a mushrooming belief that levees must be augmented by auxiliary flood-control measures, despite the disproportionately larger costs of most other methods.

The flood of 1927, like most previous floods, produced an epidemic of articles by experts, or self-proclaimed experts, who knew who to blame for past floods and how to prevent future ones. The usual scapegoat was the Commission or the Corps which dominated it. Critics hastened to suggest innumerable plans which the Corps should adopt: wells must be dug under the riverbed to contain all surplus water; others argued that large evaporation vats would solve the problem; still others suggested dredging a half-dozen artificial, concrete-lined, waterways to parallel the Mississippi all the way from St. Louis to the Gulf.

Of all the alternate suggestions proposed by the private sector, perhaps the most responsible was the comprehensive plan recommended by Gifford Pinchot, former governor of Pennsylvania and a respected

Edgar Jadwin

Charles Potter

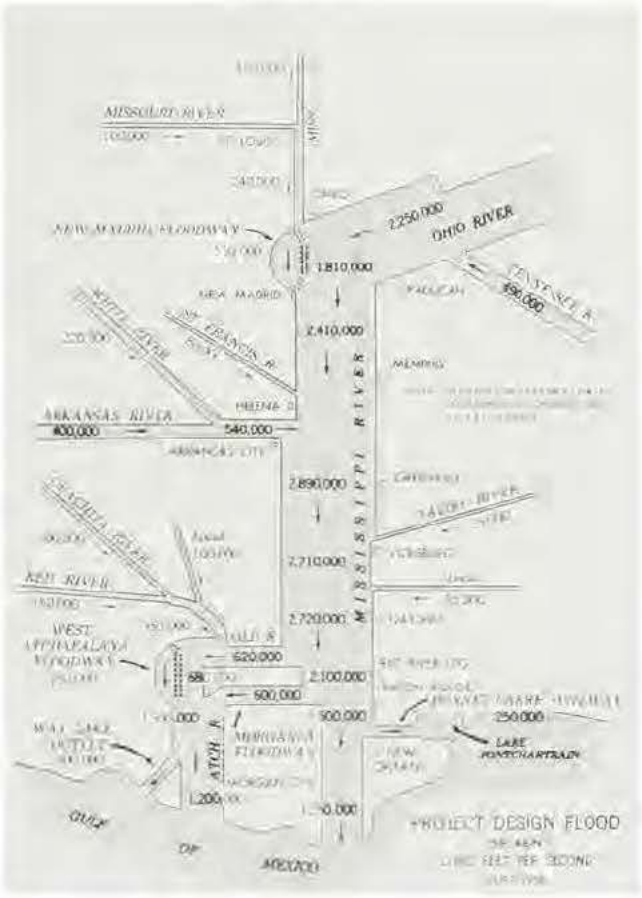
forester. "Levees are absolutely indispensable," Pinchot editorialized. "But the policy of 'levees only' is suicide. Every practicable means, device, and method of stream control must be utilized, and none neglected." A particularly far-sighted element of Pinchot's plan was the suggestion that a series of government storage reservoirs be built. The electricity which these reservoirs were capable of producing could be sold by the government, for distribution by others, and would provide considerable funds for the development of this comprehensive flood-control plan.

THE JADWIN PLAN

The plan ultimately adopted for the reclamation and protection of the valley was a modification of Pinchot's ideas, but it was the most comprehensive plan the Federal government had yet agreed to finance. The issue of Federal responsibility, which long had hampered flood-control work, was dead. Those valley residents who had opposed Federal aid because it violated the principle of states' rights now recognized that they had no choice but to accept it. A Nation that had been disrupted severely, economically and socially, for 3 months was now willing to admit that it had a vital stake in the welfare of the valley.

In the midst of the 1927 disaster, President Calvin Coolidge requested both the Engineer Corps and the Mississippi River Commission to study the Mississippi Valley problem and present their recommendations for solving it at the earliest possible date. The plans submitted at the end of 6 months by Lieutenant General Edgar Jadwin, Chief of the Corps of Engineers, and Colonel Charles L. Potter, Head of the Mississippi River Commission, were basically the same, with the exception of two key issues: estimated cost and responsibility for damage.

Jadwin estimated that the execution of the plan would require a sum just short of $300 million; Potter submitted an estimate of $775 million. The Mississippi River Commission Head also expressed the belief that the government should pay damages to any citizens whose property decreased in value as a result of the execution of the plans. Jadwin did not agree. Predictably, the more economical Jadwin Plan was ultimately adopted with its



passage of the Reid-Jones Act of 1928.

The plan adopted by Congress authorized the most extensive—and most expensive—flood-control works ever executed by the United States government. General Jadwin had called for a comprehensive project that improved the Mississippi from the Ohio Valley to the Head of the Passes. His plan was to include floodways, spillways, levee improvements, channel stabilization, comprehensive mapping, and the maintenance of a navigable channel not less than 300 feet wide and 9 feet deep. It did not include cutoffs, which Jadwin deemed harmful, or reforestation policies, which he considered ineffectual. Neither did it include reservoirs on the Mississippi itself, since their cost could not be justified by the results it would effect. However, Jadwin did recognize the feasibility of reservoirs on the Mississippi's tributaries and suggested that these be studied as part of a comprehensive plan already under way to determine the best use of all water resources.

The Jadwin Plan was basically founded on the Corps' realization that "all the water flowing at times through the lower Mississippi Valley could not be safely carried in the leveed channel of the main river." Under the terms of the Act of 1928, some 12 million acres of riparian land would be protected from the overtopping of levees, but another 8 million acres of the lowest land would be reserved as a floodplain for the Mississippi in its highest stages. All estimates within the plan were based on a hypothetical "Project Flood"—one that the Mississippi River Commission and the Weather Bureau viewed as the maximum flood possible or probable. Jadwin also firmly held to the principle that local interests should participate financially to some degree. As passed under the Reid-Jones Bill, his plan called for local provision of rights-of-way and maintenance of the work after completion.

Within the Vicksburg District, Jadwin's plan called for five measures. Local levees, in strategic points, would be set back. The Corps had long waged a campaign against local interests who insisted upon building levees as close to the banks as possible in order to utilize more of their land. This crowding of the banks seriously reduced the carrying capacity of the

River commerce was hardly affected by the flood, except when boats were volunteered or drafted to evacuate flood victims

river. Jadwin also called for moderate raising of the levees, progressive revetment of caving banks in the District, and improvement of the Mississippi's navigation channel to comply with the new overall standards.

The key feature of General Jadwin's plan for the Vicksburg District was the establishment of a floodway in the Tensas Basin of Louisiana. The levees between the mouths of the Arkansas and Red Rivers were considered insufficient to carry extreme floodwaters. The Boeuf River, located in the middle of this region, provided a natural floodway for excess water, but the entrance to this floodway had been closed by a safety plug section of levee in the fiscal year 1921-1922. The plug had washed out in the superflood that occurred soon after, but it had been repaired.

The Jadwin Plan contemplated raising all levees on the west bank of the Mississippi from the Arkansas to the Red, with the exception of the safety plug section. Normal floods would not overtop the lower section; but, should another superflood occur, the Boeuf River fuse-plug levee would fail as a planned release and the excess water would flow down the Tensas Basin to the Red River and the Atchafalaya.

The steamer CONTROL *carried Major John Lee and influential Congressmen and Senators to devastated areas in the District. She was the scene of many early talks concerning postflood rehabilitation and the future of flood control*

Damage to surrounding countryside was estimated to be minimal, since the region was 60 percent swamp and timber.

Throughout the Nation, the Jadwin Plan generated considerable support. Representatives of the *Magazine of Wall Street* heralded the development this region would soon experience. "Greater business development is coming to the Mississippi Valley in the next 10 years than it has ever known before," one New Yorker predicted.

The Reid-Jones Act was expected to stimulate industrial growth, not just in the valley but all over the country. More northern capital would flow into the region; the potential of its lumber industry would be realized. The very magnitude of the engineering project and its need for supplies would increase rail activity. The employment of thousands of workers would stimulate retail trade. Moreover, the demand for more, newer, and better equipment to complete the jobs would "produce far-reaching effects throughout the business structure of the Nation." A new era, assuredly, had dawned in the Mississippi Valley.

CHAPTER V
A COORDINATION OF EFFORTS: FLOOD CONTROL AND NAVIGATION IMPROVEMENTS

Grant that we may
Use wisely, ancient river,
The force you gave to us, the
mingled fire and water
Till ended is our day.

John Gould Fletcher

TOWARD A COMPREHENSIVE PLAN

Within the past 50 years, American society has experienced unparalleled economic and social expansion. Acceptance by the American public of its responsibility for flood control in the Mississippi Valley was but one sign of a revolution in thought that significantly affected the mission of the Corps of Engineers. Traditional ideas have been challenged more rapidly than ever. New demands have been made by a public with changing needs and attitudes.

The need for comprehensive planning for

Dredges like the JADWIN *have made year-round navigation of the Mississippi River a profitable reality*

Narrows Dam, near Murfreesboro, Arkansas, was completed in 1953 as the District's first power producer

the management of the Nation's waterways long has been evident. Within the Mississippi Valley, for example, the Engineers learned early that they could not effectively execute work on one stream without considering the cause and effect relationships between that stream, its tributaries, and its outlets. By 1927 it was also apparent that flood-control efforts had to be coordinated with works of navigation improvement if either were to be effective.

Obviously, the Nation needed a master plan, one which would treat each stream as a whole from its source to its mouth, one which would consider all of the possible uses of water and all of the needs of the country at large. The old demand "the greatest possible good for the greatest number" became the early twentieth century motto of those responsible for the preservation of the Nation's water resources. These efforts toward perfecting a comprehensive plan must serve as the theme of the District's work over the past half-century.

308 REPORTS

The comprehensive plan of today had its genesis in 1925 and 1926. At the request of Congress, the Corps of Engineers and the infant Federal Power Commission compiled detailed estimates of the cost of surveying every major river basin in the Nation. The explicit purpose was the development of a master plan to coordinate the work of navigation improvement with the diverse needs for flood control, irrigation, and hydroelectric power. The completed estimates, when submitted to the first session of the 68th Congress, were assigned the number "House Document 308;" the surveys which Congress authorized in response to these cost estimates would subsequently be known as the 308 Reports.

Ten years of exhaustive study followed the submission of House Document 308—years of surveying that paled all previous survey work in America, years of water resource planning on a level never before attempted. With the completion of their 308 Reports, the Army Engineers had laid the foundation for the first and only comprehensive water resource plan in the Nation.

Throughout its development, the Corps' comprehensive plan emphasized two basic

Dike system

approaches: control of water and control of land. However, the degree to which each method has been pursued has experienced considerable variance with each major change in America.

In the wake of the 1927 flood, when the 308 Reports were still uncompleted, the Nation demanded a quick solution to the flood-control problem. The solutions then envisioned by many were far broader than the former "levees only" policy; yet a tremendous amount of unknown variables would have made the implementation of most of these solutions more of a gamble than a planned relief.

The Jadwin Plan provided a temporary solution—one that incorporated the most promising and less risky techniques proposed by America's engineers. In essence, General Jadwin anticipated the control of the rivers by reconstruction of levees, by channel improvement, and by the utilization of strategic land for floodways. His successors

Horsepower replaced mule power after the high water of 1927

A potamologist's view of the 1973 high water. The city just right of the river is Greenville, Mississippi

introduced floodwalls, drainage canals, and watershed improvement. Each innovation met a new need, yet all generated controversy as the public failed to agree on the definition of "the greatest good for the greatest number." With each new demand and each new innovation, the decisions and activities of the Corps of Engineers would become yet more demanding.

POTAMOLOGY AND THE REVOLUTION IN RIVER SCIENCE

As the science of river engineering grew more complex, the Engineers at Vicksburg became increasingly concerned. Modern needs were far outstripping the existing knowledge of river behavior. Current data were seriously insufficient, and the existing manpower force could not conduct the needed degree of additional research while also performing the tasks Congress had assigned.

Full-time potamologists were critically needed, engineers whose expertise far

Cutterhead dredge constructing a cutoff on the Mississippi River (in background) at Caulks Neck, approximately 20 miles above Greenville, Mississippi. Dragline was also used

exceeded basic hydraulics. The latter—and older—science, which basically concerns itself with the flow and control of fluid forces, would remain a vital part of water resource management, but the complexity of modern problems has required the coordination of hydraulic engineering with geology and other earth sciences.

To fill this need, a potamology section was established at Vicksburg in the early 1960's—the first such group in the Lower Mississippi Valley Division. Over the last 15 years, it has considerably revolutionized the theory and the methodology which the District applies in its work of river improvement.

Historically, those involved in hydraulic improvements have sought to bend rivers to the needs and designs of man, adhering to the belief that each river's natural tendencies can be made to conform. By contrast, the potamologist has emphasized that each individual channel possesses a tremendous amount of variables which make absolute conformity impossible. The District's potamologists today study all aspects of river behavior, all factors that motivate it, and work out an effective compromise between each river's natural tendencies and the needs of man—in short, to work *with* the river rather than *against* it to achieve optimum development of our water resources.

Over the past century, river engineering has gone full cycle. Control measures advocated by more realistic hydraulic engineers of the late nineteenth century, i.e. floodplain regulation, were rejected by more ambitious engineers and the public who believed that every corner of this untamed country would and should yield to the advance of man.

This invincible spirit was nourished by the development of the computer. Hydrologists believed that if the tremendous store of knowledge accumulated were fed, under carefully controlled procedures, into a twentieth-century computer, the ultimate means for control and utilization of our water resources would emerge. These dreams did not materialize.

Floodways were also constructed in the Yazoo River Basin. Dredge No. 2 cuts inland near Crowder, Mississippi, during construction of the Panola-Quitman Floodway in 1950

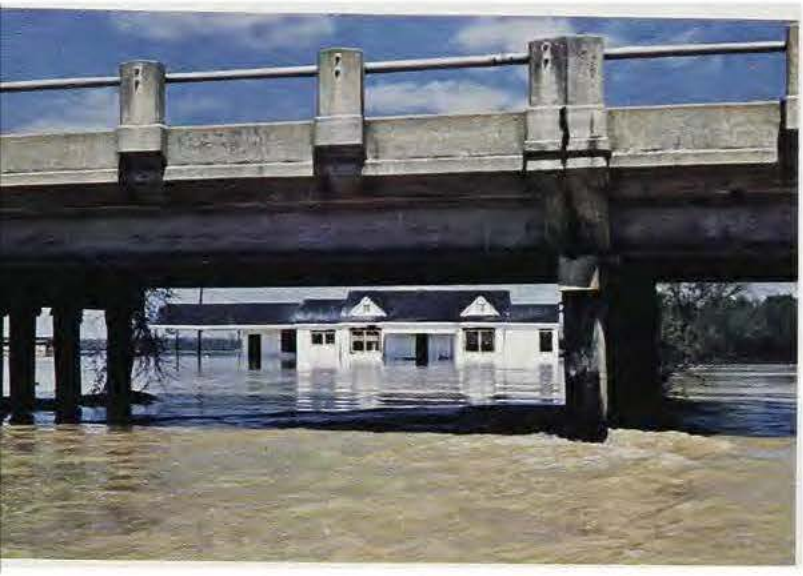
Computers have proven to be invaluable aids in assimilating and analyzing reams of data, but they are neither omniscient or omnipotent. Under the guidance of a new breed of specialists, the potamologist, today's river engineers have accepted the unpredictability of the natural force of water and the wisdom of yielding to those natural forces wherever possible in the development of water resources. Where drastic changes have to be made, the potamologist continually monitors the resulting behavior of the altered stream, interprets its trends, and develops stabilization procedures to counterbalance that stream's opposing forces.

FLOODWAYS AND FLOODPLAIN MANAGEMENT

An excellent example of the reversal of thought in river engineering is provided by the experience of the District in the area of floodways and floodplain management. The land-use controls Jadwin advocated in his 1929 plan were not a novel idea, but they were certainly among the most controversial features of his plan. Opponents of widespread flood control had long suggested that man simply stay out of those areas which served as floodplains. The Jadwin Plan represented a much more practical modification of this idea.

Jadwin was fully cognizant of the fact that levees would not be able to contain the full volume of water channelled by the Mississippi, and he recommended that certain low-lying plains be used as planned floodways. At the same time, the general recognized that men had ventured into almost all reaches of the Mississippi Valley and had struggled against tremendous odds to establish homesteads there. To advocate widespread abandonment of those properties so dearly earned would inexcusably disregard the public need. Consequently, Jadwin's sites were carefully chosen, taking into consideration the natural features of the land as well as population density, to locate floodways which would accomplish the greatest results while uprooting the fewest lives.

One floodplain was designated within the Vicksburg District, the region of Louisiana's



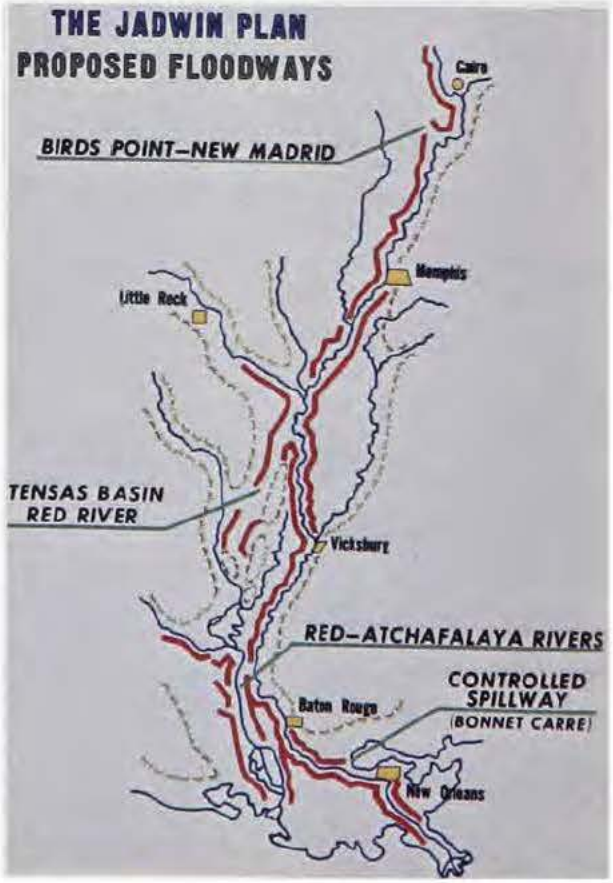
One Delta homeowner failed to heed the Corps' warning to stay out of flood-prone areas

Boeuf River Basin. Despite Jadwin's careful planning, the proposal met with considerable opposition. The designation of the area did not require complete abandonment of all flood-control measures in the area; to the contrary, the existing levees would remain at the same height. Since levees elsewhere were to be raised, however, residents of the proposed floodway anticipated far more frequent flooding.

The flood factor, too, had been considered in the formulation of the plan. Jadwin's best hydraulic engineers anticipated that the basin would flood at the same frequency as before, once each 12 years. Still, area citizens demanded the higher levees promised to other valley residents or financial remuneration for the anticipated decrease in their property values, a demand which Congress could not meet. In the face of this public opposition, the plan was abandoned.

An alternate floodway entrance was then proposed for the Eudora area of Arkansas, and Congress authorized the proposal as part of its sweeping Flood Control Act of 1936. As planned, a fuse-plug levee near Eudora would protect the area from normal flooding, but if another superflood should occur, the plug would fail. The Macon Ridge to the west then would channel the floodwaters down Bayou Macon, through Tensas, Black, and Red Rivers, into the Atchafalaya River Basin of Louisiana. After receiving Congressional approval the Vicksburg Engineers proceeded with preparatory investigations and plans.

This floodway was also doomed, though under happier circumstances. In the years between the adoption of the Jadwin Plan and the receipt of authority to relocate the floodway, a chain of events propelled the activities of the Vicksburg Engineers into a new direction. A natural cutoff in the Mississippi River at Yucatan Neck in 1929 had produced such beneficial results that the

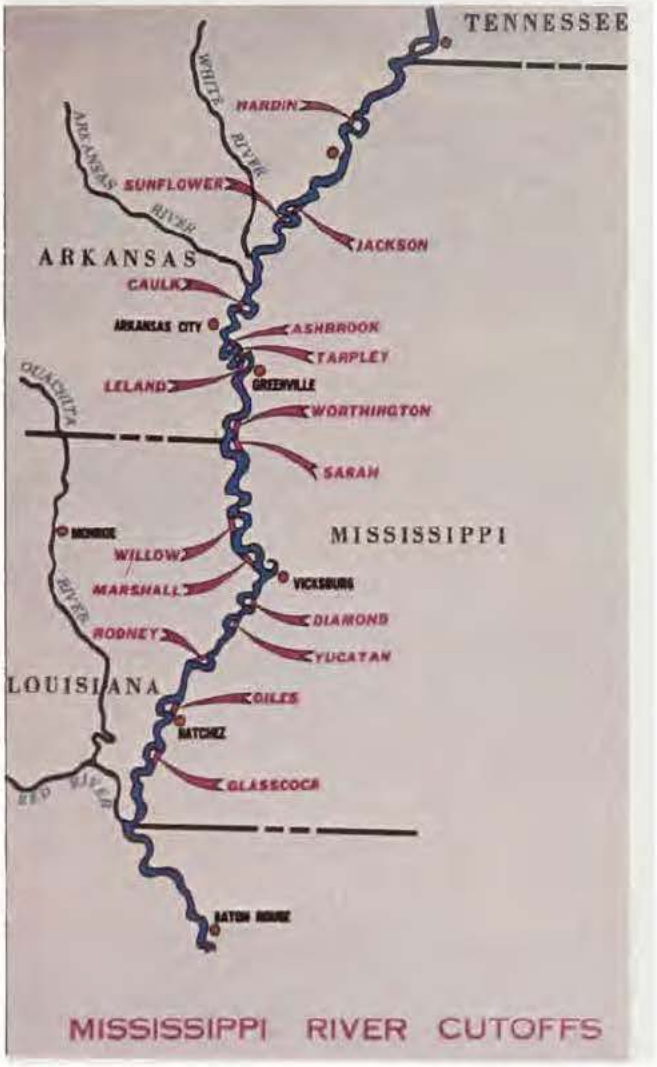


Mississippi River Commission adopted a program for a series of 14 similar cutoffs along the Mississippi, 12 within the Vicksburg District.

Construction of the cutoffs continued throughout the 1930's and early 1940's. With the completion of the project, the river was shortened by 152 miles, the downstream trip reduced a full day. The river's flood stages were lowered considerably and the velocity of the current quickened. Before the cutoffs, a bank-full flow at Vicksburg had carried a million cubic feet of water per second; afterwards it was capable of discharging 1.4 million cubic feet per second at the same gage.

The year 1937 brought another superflood to the Mississippi Valley. Along the upper reaches of the Mississippi and its tributaries, particularly in the Ohio Valley, the populace suffered unparalleled devastation. Yet, by the time the floodwaters had reached Helena, Arkansas, much of the danger had subsided. The 11 cutoffs between the Arkansas and the Red River passed the floodwaters downstream with unprecedented speed, and the tremendous levee-strengthening program conducted by the Engineers over the prior decade had produced the most secure system of levees ever. The flood fight of that winter required an army of men along the levees but the levees did hold, and the Mississippi discharged into the Gulf an "all-time peak load."

The safe passage downstream of the highest floodwaters recorded on the upper Mississippi convinced the lower valley and its engineers that an effective solution to flood control was at last under way. Most people



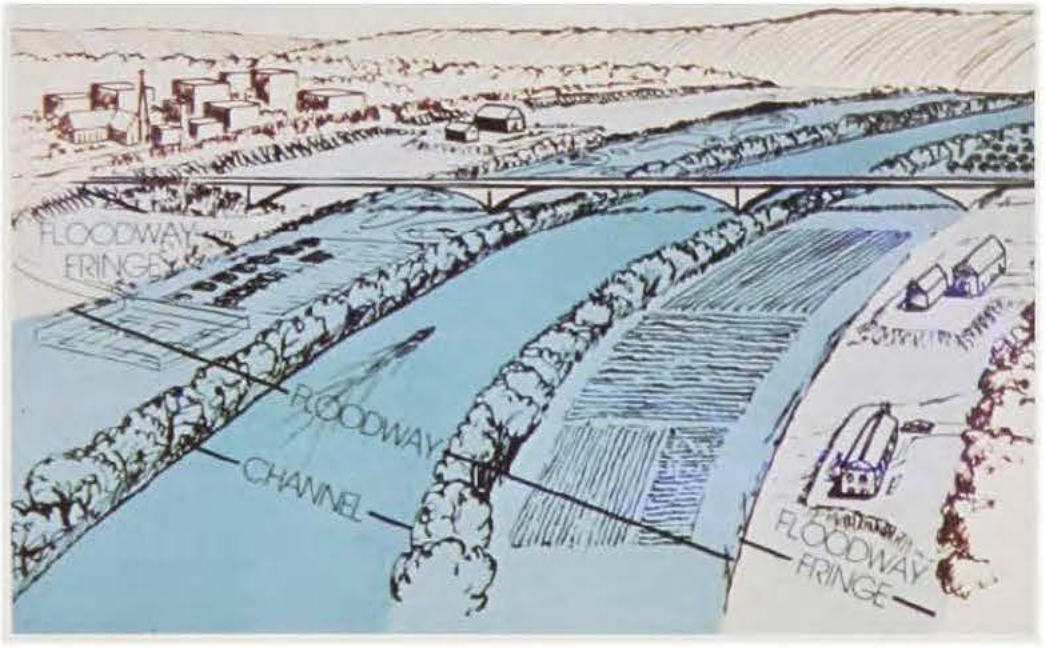
concerned were convinced that there would be no need to proceed with work on the Eudora Floodway. The Army Engineers postponed the project, the Mississippi Valley Flood Control Association petitioned for its abandonment, and in 1941 Congress deauthorized the project.

The abandonment of the Eudora Floodway did not mean the abandonment of the principle of floodplain regulation—indeed, it intensified proregulation sentiment. The destruction wrought by the flood of 1937 in the upper Mississippi Valley created a new public awareness of the need for regulating the use of lowlands. The Flood Task Force of the second Hoover commission strongly recommended less public exploitation of floodplains.

By 1942 there was an almost complete reversal in emphasis within flood-control

The water marks on the floodwall at Vicksburg will not let locals forget the years of crisis. The 1927 flood, by far, heads the list of the tragic floods

Man's works are small when compared with the works of nature. The levees protect a small Delta town from doom

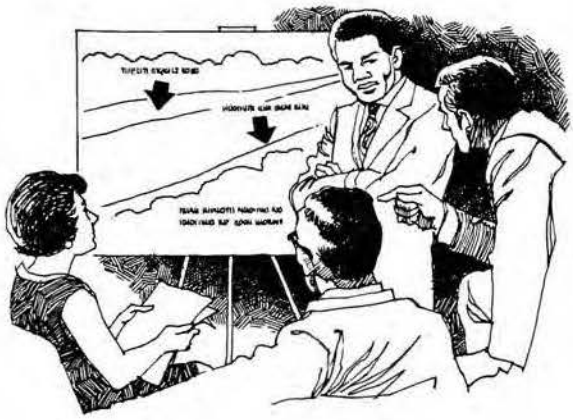


Flood plain regulation

literature. The issue had shifted from "how can man prevent flooding along the river's banks?" to "should man encroach too closely upon the river's plains; and, if so, to what extent and for what purposes?".

However, even though there was a great deal of discussion on the subject of floodplain management, very little was being implemented. By 1958, only 50 farsighted local governments across the Nation had adopted zoning laws regulating floodplain usage, but within the next decade it would become accepted practice nationwide, as local and state governments sought to provide for the safety and welfare of its citizens as well as to make best use of its lands.

The logical agency to shoulder the burden of floodplain management has been the United States Army Corps of Engineers. The Corps had noticed early that a strange relationship existed between the amount spent on flood control and flood damages: as the former



increased, so did the latter. In effect, more money was being spent on flood control and very real progress was being made, but the problem still was not being solved because flood damages were increasing.

The cause of this seemingly contradictory situation is an obvious one: as the valley became more densely populated, residents are forced to locate in high-risk flood areas. Both quantitative and qualitative development has occurred in these areas on a large scale. Because of its extensive experience in hydrological work the Corps has been recognized as the best-equipped and best-qualified agency to identify the critical flood regions. And, by identifying these high-risk areas and encouraging the public to avoid them, the Engineers simultaneously decrease the extent of future flood problems as well as future demands for flood control.

A significant step forward in the development of floodplain management was made in 1960. With the passage of its flood-control act of that year, Congress broadened the responsibilities of the Vicksburg District to include the preparation of Flood Plain Information Studies which might be requested by state and local governments. Since the passage of that legislation, a number of low-lying regions in the midvalley have sought help in municipal planning.

In response, the Flood Plain Management Services Program of the District identifies flood problems when they exist and informs the local agencies of the nature and extent of these problems. Through the use of

Hamilton Heights subdivision in Vicksburg. A sudden, heavy rain and residents scurry to save belongings

Private levee

photographs, maps, profiles, precipitation and flood records, as well as future flood projections, the District's reports not only identify the specific areas subject to floods, but also the expected elevation of projected floods. In those situations in which buildings must be constructed regardless of flood risk, a builder can at least plan the elevation to which he must build in order to stay above the probable flood level.

In this area of responsibility, the obligations of the Vicksburg Engineers are held within certain defined limits. The Flood Plain Management Services Program can never *compel* citizens to avoid flood-risk areas; it can only *encourage* them to do so. By preparing and distributing literature on the subject of floodplain construction, the Engineers provide the information needed by the public to make informed decisions on the issue.

By contrast, other agencies of the Federal government have a broader responsibility, and the Corps of Engineers remains obligated to assist them in their work. In 1966, President Lyndon B. Johnson issued an executive order requiring all responsible Federal agencies to investigate flood hazards faced by any building that involves Federal funds, and the Corps was instructed to assist in the effort. The ramifications of the order have been extensive. The Federal Housing Administration (FHA), for example, has become one of the Nation's largest home mortgage agencies, and no loans can be made through the FHA for homes that are in high-risk flood areas. Moreover, most mortgage agencies in the private sector operate under Federal insurance. The consequent pressure on the builder to avoid high-risk areas is considerable.

A second Federal agency heavily involved in floodplain regulation and regularly requiring the assistance of the Vicksburg District is the Federal Flood Insurance Program operated by the Department of Housing and Urban Development (HUD). At present, no less than 40 studies are under way within the District, all requested by HUD to help its insurance branch.

By determining the degree of risk involved, the Vicksburg District can effectively determine whether a community actually belongs within the emergency program or whether it can be covered by regular insurance. Too, those regions that contain high-risk areas must develop floodplain zoning regulations which correlate with the degree of hazard involved. Here again, the Corps is involved only in the conduction of studies, most notably in this

District in the areas of preparing model zoning regulations for Delta cities and developing floodproofing procedures for residential homes.

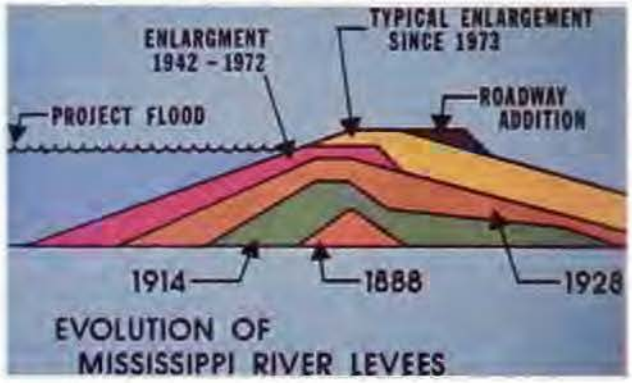
The Flood Plain Management Services Branch of the Vicksburg District has grown significantly since its formulation. From one part-time engineer in the early 1960's, operating out of a related branch office, the task force has expanded to a full-fledged branch with six employees. Undoubtedly, the program will continue to expand as long as the midvalley continues to develop or as long as Congress or the President continues to add new responsibilities.

LEVEE AND FLOODWALL DEVELOPMENT

In the wake of destruction caused by the superflood of 1927, levees fell somewhat from public favor. No longer could they be considered the ultimate bastion of defense; yet they still remained an indispensable factor in the master plan which subsequently developed. Levees alone could never suffice; but, without them no other methods could be successful.

By the advent of the next superflood in 1937, the basic levee-strengthening program planned by Jadwin had almost been completed in the District. Only a few weak pockets remained in areas where levee work could not be completed until other improvements were instituted. By the 1950's, the District's levee program had tapered off to a minimum of activity. Most levees had been updated and modernized, graded, sectioned, and removed from the critical list.

As of June 1975, the Vicksburg District contained 461 miles of main-line Mississippi River levees—186 miles on the east bank in Mississippi, 76 miles on the west bank in Arkansas, and 199 miles on the west bank in Louisiana. Several hundred miles of levees along the tributary streams have also been constructed by the Vicksburg District. Several hundred more miles are authorized for construction in the Yazoo and Tensas Basins.



EVOLUTION OF MISSISSIPPI RIVER LEVEES

All main-line Mississippi River levees have been constructed; however, some are not up to Project Design grade. During the flood of 1973, it became apparent that the efficiency or carrying capacity of the Mississippi River had deteriorated. This meant that the same amount of water passing Vicksburg would now flow at a higher elevation. This higher potential flowline for the Project Design flow meant that some reaches of the existing levees must be raised. A portion of this work was initiated shortly after the 1973 flood and is presently in progress. By its completion, 173 miles of main-line levees in Louisiana, 27 in Arkansas, and 186 in Mississippi will be raised to the required grade and section. In addition to bringing levees up to the new Project Design grade, it is necessary to provide a continuing inspection and maintenance program for the vast

network of levees that is already in existence.

Until it became apparent that some levees would have to be increased in grade, the Mississippi River levee construction program consisted mainly of adding 40-foot riverside stability berms on levees that were over 22 feet in height. Where these berms have been constructed, the maintenance work required for slide failures has decreased. The District has also been constructing seepage berms on the landside of the levees where the potential for failure due to water seeping under the levees is present. These berms are generally required in locations where silty or sandy deposits are at shallow depths beneath the levees. Construction of the seepage berm lengthens the seepage path so that if piping does develop, it will exit at a point beyond the berm. These exit locations (boils) can be controlled by construction of small sandbag dikes. Forcing the seepage paths well beyond the limits of the levee section by construction of the berms removes the potential problem area beyond the limits of the levee so that emergency action can be taken to control the seepage before the levee is undermined.

Levees resulted in a general clearing of available farmland on the landside of the man-made earthen walls

Appropriations for berm construction have been small. However, the heavy rainfall and consequent flooding experienced in recent years have emphasized the value of the berms, and the program is expected to expand. Present plans call for the construction of some 250 miles of berm in crucial areas along the Mississippi River levees in this District.

A relatively recent problem in levee maintenance work has been caused by the invasion of the fire ant. This insect of the genus *solenopsis*, which is indigenous to Central America, first appeared at the Port of Mobile in 1918, and its activity was mainly confined to that region for several decades. By the 1950's, however, the hardy and prolific fire ant had begun a rapid migration and has progressed as far northward as Greenville. The resulting problems have been multitudinous.

Fire ant mound

The Vicksburg Engineers became involved in the fire ant control studies in late 1975. A number of levees within the District had become infested with ant colonies, and the public had begun to question whether the ant burrows might endanger the structural integrity of the levees or create wave-wash problems. In response to public anxiety, the District conducted numerous field investigations in the months of December 1975 and January 1976, with the expressed purpose of determining whether the fire ant infestations might threaten the flood-control work of the Corps.

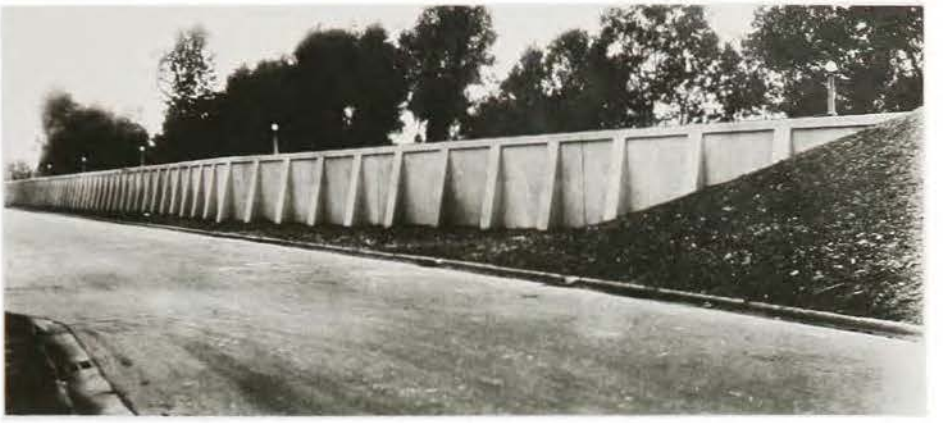
The results of the District's study, which covered the levees of all three states in the District, concluded that the fire ant did not pose a hazard to the levees. However, the ant colonies are a nuisance and an "expensive detriment" to the levee maintenance program, since they are responsible for lost work time and painful injuries. Consequently, the investigation recommended that the District continue careful monitoring of the fire ant infestation, coordinate its work with that of levee boards, and participate in appropriate experimental work which promises more efficient methods of pest control.

An auxiliary feature of the levee program within the Vicksburg District has been the construction of floodwalls for the cities of Vicksburg, Greenwood, Belzoni, Jonesville, and Monroe/West Monroe. In such urban areas, levees are impractical. Homes and businesses have long lined the riverbanks. In constructing traditional levees, with wide earthen bases, engineers of the past often were forced to take from cities entire blocks of lots. By contrast, a modern concrete floodwall, although more expensive, requires a minimum of encroachment upon city property and provides an equal degree of protection.

Construction of floodwalls at the twin cities of Monroe and West Monroe began soon after the passage of the Flood Control Act of 1928. By the mid-1930's, the work was complete except for one 1750-foot gap between Monroe's Grammont Street and Bry Avenue, where difficulties arose over rights-of-way. The problem was not completely resolved until the 1970's, when that city's urban renewal and downtown revitalization project facilitated the acquisition of the rights-of-way.

In several respects, the 30-year delay proved advantageous. Technological advances have enabled the Engineers to construct an ultramodern floodwall through this section that provides increased protection and esthetic appeal. The cantilevered design of the newer floodwall enables the facility to serve as a sidewalk when not needed, providing the city with an unobstructed view of the Ouachita River.

At Vicksburg a protective floodwall was built by private interests even before the Engineers received Congressional authorization to construct such protective



Stationary floodwall in Monroe, Louisiana, completed in 1935

Monroe city front prior to construction of collapsible floodwall. Note temporary levee on Grand Street

Folding floodwall

Old floodwall

devices. In 1923 and 1924 the city of Vicksburg, two regional railroads, and private property owners entered into a cooperative cost-sharing effort and based their design upon the high-water level obtained by the flood of 1922. Within 3 years of its completion, it became evident that the wall, which was built at a cost in excess of $2.5 million, would not be adequate. The superflood of 1927 came within a foot of the top of the wall and, had more levees held upriver, the floodwall certainly would have been overtopped. Again in 1937 the river crested at a disturbingly high level along this wall.

Obviously the floodwall had to be replaced; the height was below that necessary to safely pass the Project Flood. In fact, the floodwall was below the grade of the levee opposite Vicksburg. The District's Engineers conducted the necessary preparatory studies, but funding was slow in coming.

Work finally began in the summer of 1952 on a new floodwall designed 6 feet higher and of much greater strength than its predecessor. Openings were provided at major access points and equipped with stop-log closures for use when river stages make it necessary. Special features were incorporated at railroad crossings, and the city of Vicksburg cooperated by making alterations in its pumping plants which evacuate sewage and local drainage during flood stages. Upon its completion in 1959, the city assumed complete responsibility for its operation and maintenance.

New floodwall

GENESIS OF YAZOO BASIN DEVELOPMENT

The most challenging effort made by the District in its development of a comprehensive plan for its waterways has been in the Yazoo Basin of Mississippi. In the early years of the District, little work was accomplished in the Yazoo-Mississippi Delta; emphasis, instead, was placed upon the more heavily populated Red River region of Louisiana. By the turn of the century, distribution of work in these two basins had begun to equalize and since the flood of 1927, the focus has indisputably been upon the Yazoo.

A half century of study, planning and modification of planning, construction, and reconstruction have been devoted by the Vicksburg Engineers to ease the desperation of the residents of the Yazoo-Mississippi Delta. The resulting improvements are believed to constitute the most advanced flood-control system in the world today, and probably the most complex.

Steele Bayou Drainage Structure, the first and largest structure in the Yazoo Backwater Project

The acquisition of Congressional approval for full development of the Yazoo Basin was extremely slow in coming. Years of public pleading and Congressional bargaining were necessary before Congress authorized the first step in the development of the Yazoo Basin. The prime mover of the proposed work, without question, was the late Congressman Will M. Whittington of Greenwood, whom many valley residents revere even yet as the "Father of Flood Control" in Congress. It is still related in the area that after all else had failed, Whittington won his support of his colleagues with a purely personal approach.

As chairman of the House Flood Control Committee, Whittington insisted that his committee examine the situation personally, and he invited them to his Delta home. At dusk

of the evening, with the mosquitoes "so thick you could pan them," Whittington took the committee out on his place and droned on as incessantly as the mosquitoes themselves on the value of the country they were inspecting and its need for flood control and drainage (which would also rid the area of that pestilential insect). The committee returned to Washington, red with mosquito bites, blue from hours of slapping, and thoroughly convinced that the plight of the Deltans had to be relieved.

Whether the above story represents fact or fiction is not known. Congress—under Whittington's leadership—approved the first phase of the Yazoo Basin development program in 1936, and the complexity of the work to be done was recognized by Congress from the start. In general work within the basin over the past four decades may be divided into three basic project areas: headwaters; backwaters; and Sunflower River Basin. Within each of these areas, subareas have been developed that are, in fact, projects in themselves. In the headwater project alone one can find illustrations of every type of flood-control work except paved channels. When the correlating Yazoo Basin projects are added, the system seems even more complex.

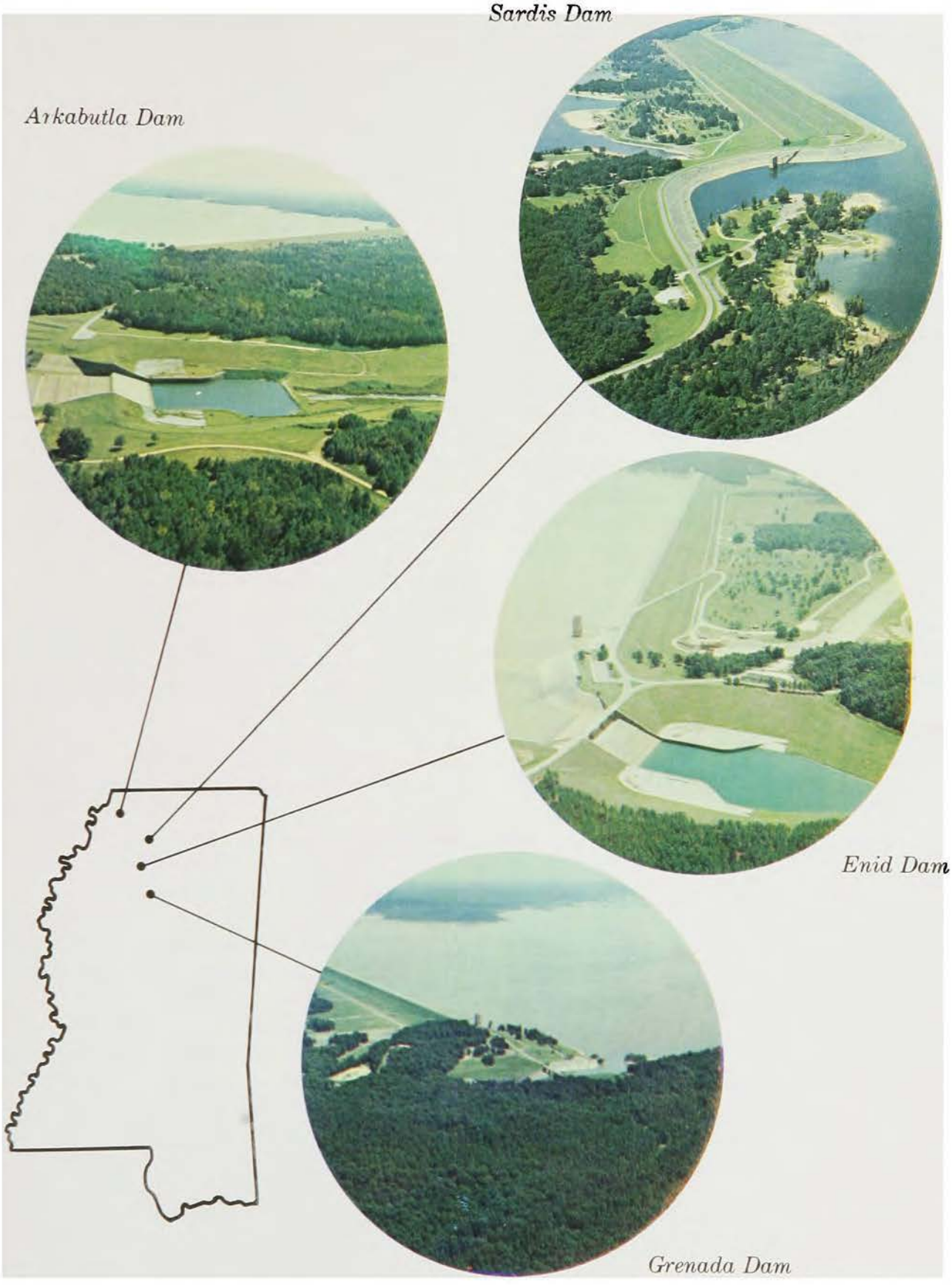
YAZOO HEADWATER PROJECT

The legislation pushed to reality by Congressman Whittington in 1936 focused upon the Yazoo headwater problems. The project that has since developed can be subdivided into five features: (1) reservoirs; (2) main stem work, including channel improvements, bank stabilization, levees, and auxiliary channels; (3) drainage improvements for the principal Delta tributaries; (4) control of the small tributaries between the hill line and the main stem; and (5) local protection works for certain urban areas.

In preparing the proposal for the original headwater project, the District actually submitted to Congress seven alternate plans. Each plan combined different flood-control features in a variety of patterns, but all included reservoirs (ranging from one to nine in number) to collect and store excess runoff from hill tributaries which fed into the Yazoo Delta. After studying the proposals, Congress authorized a plan with seven reservoirs; but it also recognized the complexity of the Yazoo Basin problem and consequently granted an unusual degree of leeway to the Engineers in this project.

Under this Flood Control Act of 1936, authority was given to the Chief of Engineers to substitute levees, floodways, and/or auxiliary channels for any or all of the reservoirs needed on the Yazoo headwaters. Subsequent study by the District revealed that four strategically located reservoirs would be capable of storing essentially the same amount of water as the seven that had been authorized, and the adoption of the four-reservoir plan effected considerable savings to the public treasury.

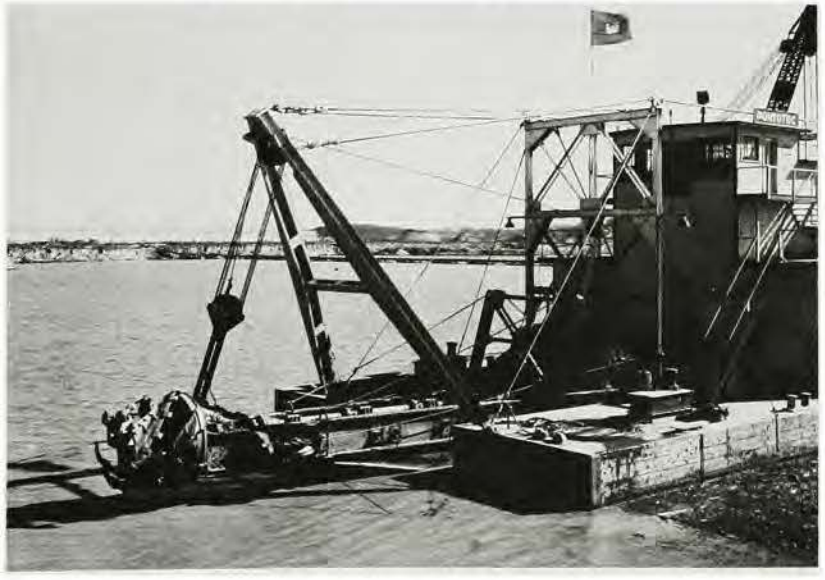
Construction began on Sardis, the first reservoir and dam, in 1936—after considerable difficulties caused by unsatisfactory bids and labor problems. By October 1940 the project was in operation, boasting the latest engineering techniques in design and construction. Basically, releases from the reservoir were designed to be


Sardis Dam
Arkabutla Dam
Enid Dam
Grenada Dam

Sardis spillway was used for the first time during 1973 flood season

regulated by a gated outlet structure which not only provided maximum flood-control benefits but also such incidental plus factors as irrigation, water supply, and quality control.

To prevent the dam from being overtopped or endangered by unusual amounts of pressure, an uncontrolled chute-type spillway was included in the north abutment. Constructed to accommodate the largest flood on record at that time, the dam has proven to be extremely effective; only once—during the unparallelled precipitation of 1973—has the spillway been overtopped.

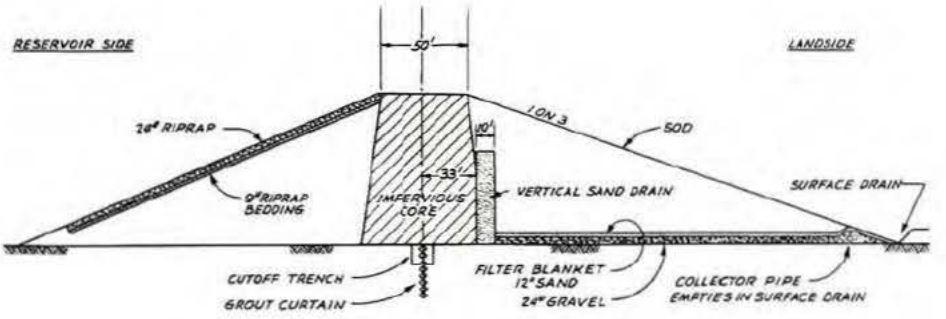


Dredge Pontotoc *during its support of construction at Sardis Reservoir*

In retrospect, the most significant feature of Sardis Dam, outside of its flood-control value, was the methodology used in building it. The project is a hydraulic-fill dam. Not only was it the first such project in the District, it also was one of the earliest (and at that time the largest) in the Nation. In the implementation of this technique, the District designed and built its own portable, electric, cutter head, hydraulic dredge, the *Pontotoc*. Retaining dikes were built on the site and the dredged material was pumped between the dikes by the *Pontotoc* as it excavated a small lake below the dam. The methodology used in this operation by the District was so perfected, in fact, that it was adopted for use on larger structures built by other districts (i.e. the dams on the Missouri River).

Construction of the Arkabutla Dam and Reservoir followed on the heels of the Sardis project. Situated on the Coldwater River, Arkabutla was designed to control the runoff from 1000 square miles of hill land which drained into that Yazoo tributary. The dam and reservoir built at that valley bottom between 1940 and 1943 encompassed some 52.5 square miles when filled to crest. The reservoir has never been emptied entirely; a conservation pool with a minimum area of 8 square miles has been maintained since the dam's completion to provide for auxiliary purposes such as water supply and recreation.

The site of the dam at Arkabutla was a strategic one, but serious obstacles were present. As was the case at Sardis, there were railroad tracks to be relocated. A number of local roads, as well as a section of Mississippi Highway 51, crossed the reservoir site and had to be moved at Federal expense. The biggest



DIKE-TYPICAL SECTION

problem was presented by the town of Coldwater, which stood squarely on the only effective site for location of the reservoir. The entire town was moved—homes, businesses, and cemeteries—and at its new site enjoyed unprecedented growth. In 1942, at the old location, the town contained only 600 residents. At the new location, its population tripled within the first 15 years.

In the midst of construction work on these two dams, a war intervened. The two reservoirs were completed, but the remainder of the Yazoo Project had to be postponed in the face of this far-greater emergency. At the war's end, the project was immediately revived, and work resumed on the two remaining structures, Enid on the Yocona River and Grenada on the Yalobusha.

By 1954 the Mississippi-Yazoo Delta had achieved a great measure of protection, as these four vast reservoirs gathered hill floodwaters and held them until they could be safely released downstream. The combined flood-control pool of the four reservoirs totalled 3.8 million acre-feet, with 184,600 acres of land encompassed by the reservoirs. The cost exceeded $72 million. Before the construction of the reservoirs, 14,000 cubic feet per second crossed the headwater area into the Sunflower Basin during major runouts. With the completion of the project, that figure had been reduced to 4000 cubic feet per second.

The second feature of the Yazoo Headwater Project focuses upon the main stem of that river. Included are two common practices in flood-control work (i.e.

Relocation of U. S. Highway 51 bridge, Arkabutla Reservoir project

Long rows of houses built for contractor's employees sprang up around reservoir sites

Although dredging on the Upper Yazoo Project is aimed at flood control, a more stable channel will have to benefit navigation

construction of levees to confine floodwaters to the channel and the increase of channel capacity through clearing, enlargement, and construction of cutoffs) and one unusual and interesting, although not necessarily unique, feature (dual auxiliary channels).

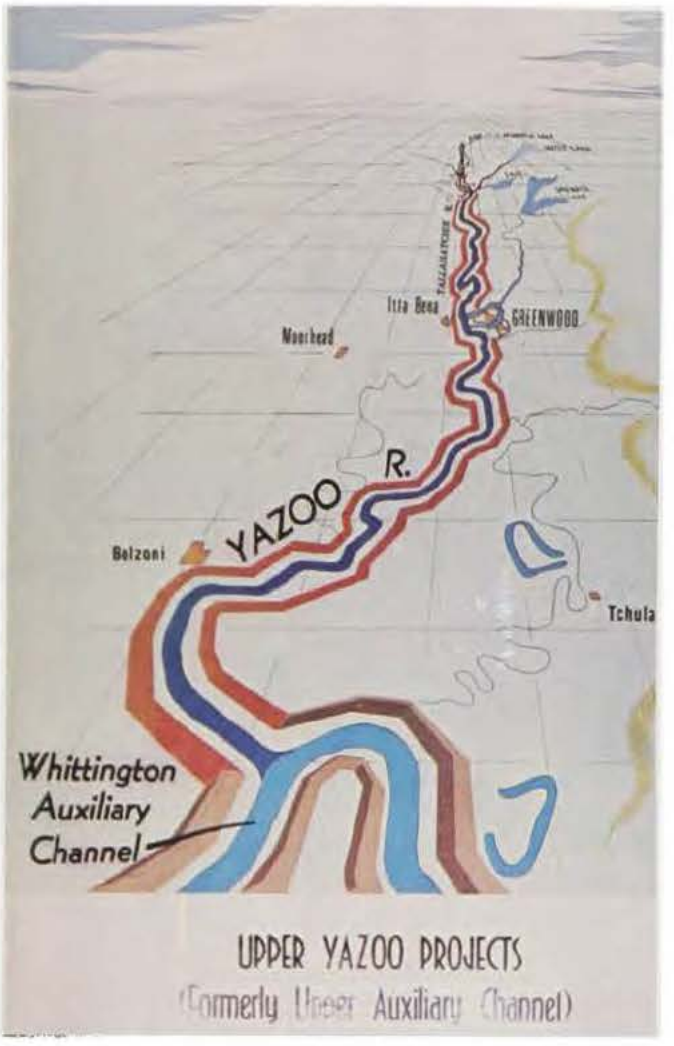
Initial plans for the dual channels envisioned an Upper Auxiliary Channel of some 56 miles in length, beginning near Webb, Mississippi, and running southward, to the west of Greenwood, to connect with the second auxiliary channel at the mouth of Tchula Lake. Improvements effected by the upper channel would be heightened by channel improvements on such northward streams as White Oak Bayou, Old Coldwater River, and Cassidy Bayou. The Lower Auxiliary Channel would leave the Yazoo near the mouth of Tchula Lake and intersect the Big Sunflower River near its juncture with the Yazoo. Completion of the two channels would

Cutoffs on the Yazoo straightened the river and gave nearby levees (foreground) relief by speeding high water downstream

drastically lower river stages during flood flows.

Only part of the dual channel project was ever completed; the lower channel was appropriately named the Will M. Whittington Channel in honor of the congressman who devoted his life to the achievement of flood control for that region. The completed work has more than fulfilled expectations; in the flood of 1973, for example, the channel reduced flood stages within the region by an estimated 7 feet.

Plans for the Upper Auxiliary Channel have been abandoned in the face of a variety of obstacles. Land values in the Delta have increased tremendously in the years since the project was authorized and are expected to continue to rise. Consequently, few landowners have been willing to yield any of their land for the excavation of a canal, even though fair present market values are offered. Too, in the



Construction in the Yazoo Basin in the first years of the comprehensive program

intervening years since the channel was authorized, engineering studies have revealed that the division of river flows tends to reduce the velocity of each flow and encourages channel deterioration within the river itself. The alternate plan to the Upper Auxiliary Channel will enlarge and improve the main stem Yazoo, Tallahatchie, and Coldwater Rivers, themselves, by as much as one-third, from the Yazoo's junction with the Mississippi up to the headwaters.

A still small but increasingly important feature of the Yazoo Headwater Project is the control of the spidery hill tributaries from the hill line to the main stem. These minor streams are an incessant problem, not only because of the volume of runoff water which they empty into the Delta but also because of the large amount of sediment that they dump into Delta streams, thus causing the filling of their channels. Under the Water Resources Development Act of 1974, and together with the Soil Conservation Service, considerable study of these streams has been conducted by the District, particularly in the area of preventing streambank erosion. Several methods, grade control structures, and a variety of bank protections are being studied and tested to find the best, least costly way of alleviating the problem.

The anticipated effect of the Yazoo Headwater Project is tremendous. Protection for an immense area will be achieved with a minimum of local input. About 1.2 million acres of land will be protected from overflow and another 303,000 acres within the District will be substantially benefitted. Moreover, this protection is directed toward a part of the extremely fertile Yazoo-Mississippi Delta which is becoming increasingly important in the production of foodstuffs for both the foreign and domestic market.

YAZOO BACKWATER PROJECT

A second major development program in the Yazoo Basin is the Yazoo Backwater Project, a program designed to protect another million acres of the Mississippi Delta. The basic problem in this region is occasioned by the juncture of the Yazoo and the Mississippi. As the levee system was built, a gap had to be left to permit the Yazoo to empty its flow into the Mississippi River. During high stages, as a consequence, the Mississippi backs into the Yazoo and floods the lower portion of the basin.

Various river improvements on the upper Yazoo have alleviated the woes of the backwater area, but the basic problem has remained. In the 1940's, Congress authorized the Yazoo Backwater Project but no funds were appropriated until the late 1950's. Construction began in the 1960's with still

Steele Bayou floodgate

minimal funding. Not until the flood of 1973 did Congress fully appreciate the dire need of the region.

The present project design incorporates a variety of flood-control measures. A major feature is the construction of the backwater levee on the west bank of the Yazoo to run upward from the Mississippi to the vicinity of Yazoo City. To date, bad weather and high water have periodically delayed construction work on the levee, but its completion is anticipated for the near future.

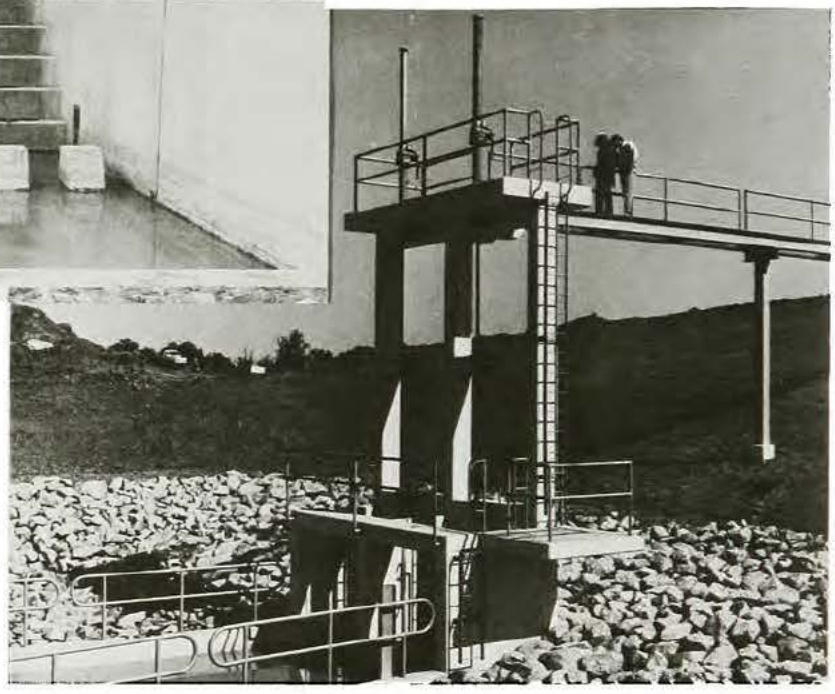
A second feature of the Yazoo Backwater Project is a system of drainage structures or floodgates and a connecting channel. A portion of the system has already been constructed or is presently under construction. At Steele Bayou, for example, a floodgate has been installed at the mouth of that waterway to permit drainage of the bayou in the Yazoo River when the Yazoo is lower than water on the land side of its levee.

The Yazoo Backwater Project is designed to provide a great measure of flood protection, but it is not foolproof. Obviously there will be ponding of water to a large extent on the land side of the levees when the Yazoo is high. Studies are now under way to determine the feasibility of installing large pumps to lift the ponded water across the levees during periods when it will not flow by gravity. Projected costs are immense; the anticipated pumps would have to be far larger than any now available. In the meanwhile, the other features of the backwater project are being pushed to completion while the Vicksburg Engineers await a decision on the pumping plants.

The third Yazoo Basin program (the Big Sunflower River Project) is actually broader in scope than its name implies. A number of tributary rivers, creeks, bogues, and bayous feed into the Big Sunflower. That river's basin, in fact, covers the bulk of the area between the Mississippi River and the Yazoo-Tallahatchie system. Historically, the Big Sunflower was a distributary stream of the Mississippi River and helped to carry the floodwaters of the main river down the Delta to the Yazoo where they fed back into the main stem. The Sunflower channel, as a result, is unusually large, but since the construction of Mississippi River levees, the Sunflower has been cut off from its major source of sediment-cleansing flows and has begun to fill.

In 1944 Congress made its initial authorization of the Sunflower Project, and it

Big Sand Creek Drainage Structure



Snake Creek Drainage Structure

has since modified that authorization several times to update project plans. Cutoffs and channel improvements have been and will continue to be made to provide adequate drainage and flood control for the area. The original project has been completed, some 592 miles of work; but labors continue on some later authorizations. When completed, the Sunflower Project will benefit still another 395,000 acres which rank among the finest agricultural lands in the Nation.

An auxiliary benefit to the flood-control work conducted within the Yazoo Basin has been the stimulation of navigation upon that river. The release of stored water from the four reservoirs during the low-water season on the Yazoo has increased the navigation season for that river from 4 to 7 months. Likewise, the channel work conducted under the auspices of the flood-control project also improves the river for navigation. Already the once-dying commerce on the Yazoo has revived, as that river becomes a small commercial highway for

agricultural produce. Demand for increased improvements is mounting, and a proposed 9-foot navigation project for this waterway has recently been authorized. Upon its completion, the Yazoo should regain its former status as a major artery of Delta commerce.

TENSAS BASIN

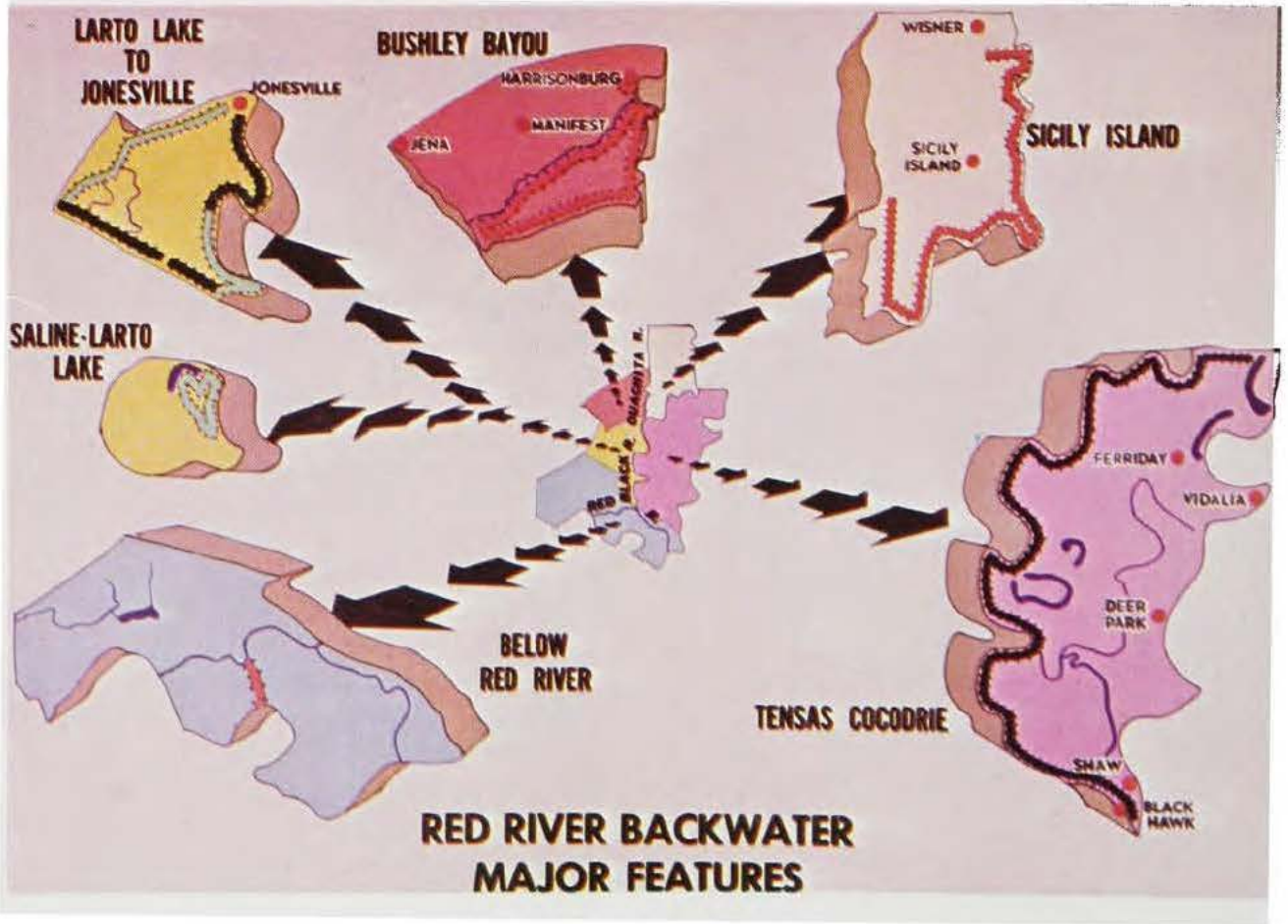
West of the Mississippi River, a situation exists which is somewhat similar to that of the Sunflower River. The region of Louisiana and Arkansas generally referred to as the Tensas Basin encompasses several waterways which long have had considerable impact upon the area: Bayous LaFourche and Macon and the Boeuf River, as well as most tributaries of the Boeuf and the Tensas. Most of the 5300 square miles included in this basin have always been subject to flooding.

Local levee and drainage boards were quite active in the Tensas Basin in the early twentieth century, digging drainage channels and building levees along the lesser streams, but their efforts had little effect. Coordination was drastically needed to provide a continuous drainage outlet capable of handling flows throughout the whole system.

In order to correct this situation, Congress called on the Corps of Engineers in 1944 to provide those major drainage outlets. Since that time, several additional works within the basin have been authorized (i.e. the Lake Chicot Pumping Plant [see Chapter 6]). As a consequence of this congressional authorization, the Vicksburg District has completed over 700 miles of channel work in the Tensas Basin and more remains in progress.

Much of the flood problem experienced in the lower Tensas Basin is caused by backwater from the Ouachita and Red Rivers which meet in the basin. Additionally, Mississippi River flows entering the Atchafalaya system through the Old River Control Structure can significantly affect flood stages in the lower basin. The nature of the problem is intensified by the fact that when one of these rivers (the Red, Ouachita, or Tensas) is in a flood stage, the other two usually are as well. The total region that is loosely called the Red River Backwater Area comprises some 1.7 million acres. Of this figure, 800,000 acres were cleared and suitable for agricultural use prior to 1972, and 500,000

Old River Control Structure, at the confluence of the Mississippi and Atchafalaya Rivers, prevents the river from taking a new bed and bypassing New Orleans



Tensas-Cocodrie Pumping Plant

of those 800,000 acres were developed in the years between 1960 and 1972. The tremendous benefits resulting from initial improvement works by the District are obvious.

To reduce this backwater flooding, the Vicksburg Engineers have developed a levee system different from the normal river levees—primarily loop levees. The first of these, the completed Tensas-Cocodrie Levee authorized in 1941, surrounds most of Concordia Parish and connects to the main-line Mississippi levee. A second loop levee in the Larto Lake-Jonesville area is currently under construction, and four additions to the backwater levee system are planned: the Bushley Bayou and Sicily Island area of Catahoula Parish, the below-Red River region of Avoyelles Parish, and the below-Larto Lake region of the basin.

An additional variety of authorized features will greatly enhance the protection provided by these levees. Floodgates, for example, are provided throughout at the outlets of major streams, and channels are included to insure adequate drainage routes for all the leveed areas. Here again, as in the Yazoo Backwater area, ponding during flood stages is a problem. A pumping plant has been authorized for construction in the Tensas-Cocodrie area, and the application of pumps is being studied for other loop levee projects.

OUACHITA BASIN

In the Ouachita Basin of Arkansas and Louisiana, river improvements have taken a different approach. The emphasis here is upon navigation rather than flood control. The problems peculiar to this river system have long created a demand for Corps assistance, but the attending costs have been astronomical and area needs have changed at a faster rate than appropriations have been made.

An excellent example of the difficulty faced in the Ouachita Basin is provided by a brief review of the first channelization project for that river. About the turn of the centry, a 6-1/2-foot navigation project was finally

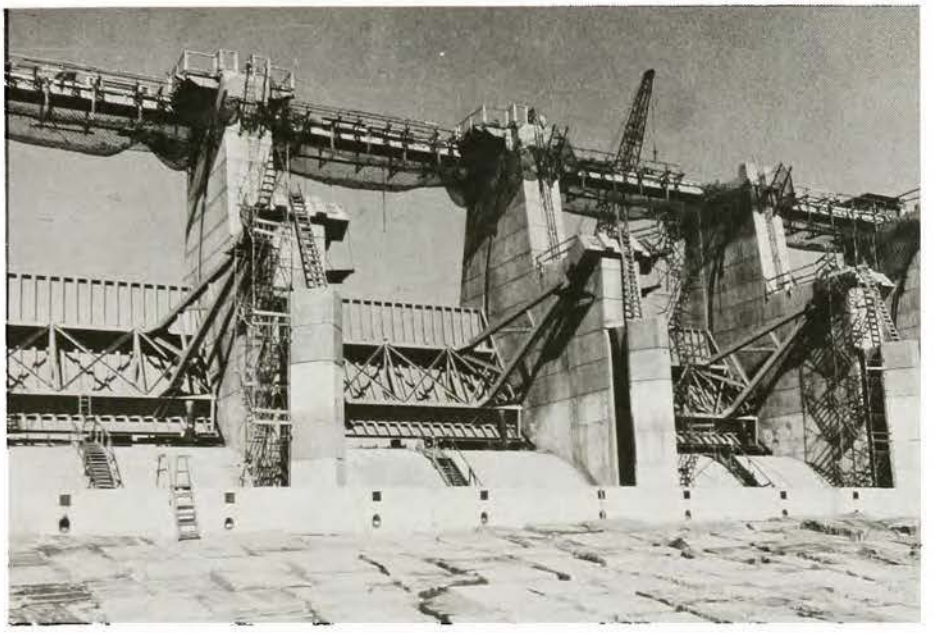
authorized after years of consideration. By the time sufficient appropriations were made and the project completed, only a few years of significant commercial activity remained before modern technology outmoded the 6-1/2-foot channel. By the end of World War II, most towboats and barges were designed for 9-foot channels, and the Federal government was seriously considering the abandonment of the Ouachita as a commercial waterway.

Members of the Ouachita River Valley Association, which long had been the motivating force behind the economic development of the area's waterways, initiated a concerted but often frustrating drive to save the Ouachita. At their urging, the 1950 Congress authorized Vicksburg's Engineers to deepen the channel to a minimum of 9 feet; yet insufficient funds stalled the actual work. Seven years later, the United States Senate Committee on Public Works requested a new feasibility study, and eventually Congress authorized a comprehensive channelization project for the Ouachita River.

The new Ouachita Project called for a strategic combination of waterway improvement works. Dredging was authorized throughout the shallower portions of the river to obtain a minimum depth of 9 feet. Where sharp bends in the river present navigational hazards, the river is being straightened to provide a minimum radius of 1000 feet in the bends. The prime feature, however, is a series of four concrete locks and dams, 84 by 600 feet, with large tainter gates to regulate pool heights, and a navigation pass to accommodate river traffic at high stages. Each structure is specifically designed to pass floodwaters in such a manner that river stages will not be increased during flood periods.

Actual construction began in 1964 with the Columbia Lock and Dam in Louisiana. Moving downstream, a second structure (the Jonesville facility) was completed by 1972. Work on the third phase of the lock and dam project, the Felsenthal Lock and Dam in Arkansas, is currently under way. Although the plans for all four facilities are basically similar, each contains distinguishing features. At Jonesville, for instance, a bascule gate has been installed on the weir of the navigation pass. Unlike normal weirs which are concrete to their full height, the Jonesville weir is topped by a flexible 5-foot bascule gate which can be raised or lowered vertically by hydraulic cylinders on each end of the 200-foot pass.

Advantages of the bascule gate design are numerous. When water depths are appropriate, traffic goes over the weir and through the navigation pass instead of through the lock itself. The bascule gate can be lowered to allow boats to use the pass at lower water



Construction of Jonesville Lock and Dam

Construction of Columbia Lock and Dam

Ribbon-cutting ceremony aboard the M/V Lipscomb at the official opening of Jonesville Lock and Dam was led by W. C. Brown, H. K. Thatcher, Major General Charles Noble, Colonel Marvin Rees, and Wedon Smith

levels than before. Too, the flexible gate helps control the upstream pool and has an automatic sensing device for that purpose. Although bascule gates are not unique, their application to the lock and dam facility is unusual, and the innovation has resulted in considerable savings in construction costs.

At the Felsenthal Lock and Dam, a European technique has been adopted which is yet quite rare in the United States. In fact, very little expertise on the construction of this feature, a slurry trench, exists in America. Experiments within the District, before the introduction of this innovation, indicated that such a trench would be of considerable aid in the ground excavation process at Felsenthal, and the slurry trench proposal was incorporated into the project design.

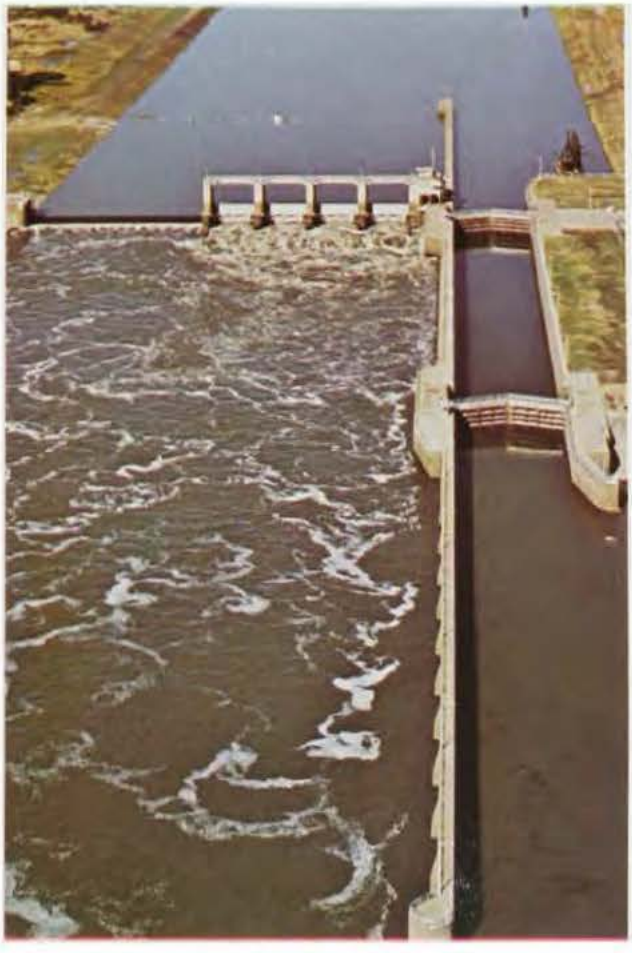
A major problem at any excavation site is the seepage of sand and water into the excavation. Numerous wells have to be driven and operated until sufficient water is drawn for the water table to fall below the level of the excavation. A slurry trench forestalls the problem. When excavation began at Felsenthal, a 5-foot-wide trench was dug until

Felsenthal Lock and Dam

Columbia Lock and Dam

an impermeable material was reached at a depth of about 40 feet. The trench was then filled with a mixture of sand, clay, gravel, and bentonite to make the trench impermeable. Pumps at the excavation site are now needed only to remove rainwater that falls into the trench. While this technique cannot be used in all situations, its adoption wherever possible does effect considerable savings in time and money.

Completion of the Ouachita 9-Foot Navigation Project will still require several years of additional construction, but its effect is already being felt. Barge and boat traffic again has become a common sight on the Ouachita, even as high as Camden. In the year following completion of the Jonesville facility, for example, barge movement on the river doubled over that which occurred the year before its completion. The finished project will generate unparalleled commerce on the Ouachita and its tributaries, if the predictions of enthusiastic local supporters prove accurate. This 9-foot system, according to Fred Petty, president of the Tensas Basin Levee Board, "will mean more than anything else ever has to our economy."



Jonesville Lock and Dam

MISSISSIPPI RIVER

Low-water season is the working season on the Mississippi River, as it has been since the earliest years of the District. In all types of improvement activity, from snag to wreck removal to dike construction to revetment, work can be carried out only when the water level falls enough to permit it. Under normal conditions, the working season begins in June or July and continues until December.

Emphasis upon the type of work performed has not remained as constant, however. In different periods of the District's history, emphasis has been placed on a variety of improvement works. Snagging, for example, which once was the principal duty of the work force, has declined to the point of near nonexistence. At present, improvement works on the Mississippi focus instead upon the tremendous revetment program.

The Vicksburg District assumed the responsibility of constructing river improvement in this main channel during the period of Corps reorganization that followed the 1927 flood. Under the terms of the sweeping Flood Control Act of 1928, the Mississippi River Commission was relieved of the responsibility of performing the actual construction works on the Mississippi. Instead,

Snagging operations

their function since has been the recommendation of improvements and supervision of work by the individual districts spanning the various portions of the river.

In the half century that has followed, Mississippi River improvements have become a major part of the Vicksburg District's work load. The primary challenges have been the improvement of the flood-carrying capacity of the river and the stabilization and maintenance of a 9-foot-deep, 300-foot-wide navigation channel between Cairo and Baton Rouge. The former has been accomplished through implementation and modification of the previously discussed Jadwin Plan. The second feature of the Mississippi River improvement project is still under construction and will be for the next several years. In this stabilization work, three principal methods are used: revetment, dikes, and dredging.

The revetment process is a slow, complex, and immensely expensive one, although the Vicksburg Engineers have continuously made innovations to overcome all three handicaps. The initial step in the process calls for the

Clearing and grading operations

clearing and grading of the river's banks. In the Jadwin era, and for decades before, hydraulic grading was the normal procedure; steam turbine and centrifugal turbine pumps directed high-pressure jets of water upon the banks to wash them down to desired slope. Today's operation combines modern bulldozers with floating draglines for maximum efficiency. Stationed at the top of the bank, the bulldozers push excess material down the bank, where the gargantuan buckets of the mammoth draglines take it out to deep water to be washed away.

Two such grading units, working at the advance of the process, prepares modern slopes to a grade of 1 on 3 through 1 on 5 for a depth of about 30 feet. Working 10-hour shifts, the two units average approximately 80,000 cubic yards per day and have, on occasion, exceeded 100,000 cubic yards in a day's work. The amount of dirt removed each day would fill to the ceiling 135 spacious 2000-square-foot homes.

A model of the machine designed and built by District forces to pick up concrete mat at the casting field

The second step of the revetment process is the covering of the graded banks which lie below water level. By the early years of this project, articulated concrete mattresses had already replaced the willow mat as the preferred revetment material. The District, however, has continued the tradition of experimentation and improvement in this area established by early engineers and has made continuous innovations which have improved efficiency. Consequently, without an increase in manpower, the average for a 20-hour work day has increased from 2400 squares in the early 1950's to 8000 squares in 1976.

The articulated concrete mattresses which line the Mississippi's subaqueous banks today are composed of units 4 feet wide, 25 feet long, and 3 inches thick. Each unit is formed with 20 uniform slabs or blocks of concrete, linked together with wire to permit flexibility for the composite mattress to fit the riverbank. The assembled units are loaded on barges, as needed, and towed to the construction site where they are, in turn, assembled on the barge's sloping deck into mattresses 156 feet wide.

As the mattresses are assembled, the launching barge moves out into the river, allowing newly formed rows of the mattress to slide off the sloping deck onto the bank. When sufficient rows have been formed to cover the desired distance, the last of the mattress is lowered and the barge moves upstream to assemble and lay the next mattress. The upper portion of the bank is then paved with broken stone for added protection in high-water periods.

Today's crews work as hard as those employed by the District in its earliest years,

The Vicksburg District's Mat Sinking Unit (above) plays an important role year after year in the overall flood-production plan. To maximize their results, the unit works around the clock (below)

Quarterboats: home away from home for the Mat Sinking Unit

but enjoy much better fare and accommodations. As a general rule on the river today, a crew which is not fed well will not stay, and the improved standards have certainly caused a noticeable increase in the District's subsistence budget. In 1976, for example, the mat unit crews consumed 25 tons of food each month. The "floating motel" in which the crews are quartered can accommodate more than 500 men, with such modern amenities as air conditioning, showers, and fire detection alarms. Televisions are provided for relaxation during the after-work hours. Electricity is supplied by diesel generation, and water is obtained through huge purification systems capable of treating 150,000 gallons a day. The quality of life upon the river projects have unquestionably improved since the days when Captain Benyaurd's small work crews were forced to sleep under the stars because sufficient tents could not be purchased.

MONTHLY GROCERY LIST
Vicksburg District Mat Sinking Unit
1976

Eggs	3,000 dozen
Milk	530 gallons
Butter	837 pounds
Sugar	3,787 pounds
Beans	753 pounds
Potatoes	6,702 pounds
Bread	1,445 pounds
Flour	4,462 pounds
Ham	1,937 pounds
Chickens	3,853 pounds
Beef	16,011 pounds
Coffee	1,008 pounds

In the work process itself, the advancements have been equally impressive. The invention of a pneumatic tying tool which fastens the concrete units together mechanically, for example, has effected great savings in time and manpower. Mat boats have been widened and lengthened to accommodate more mats and thereby speed the revetment

Linking concrete units by pneumatic tying machines make mat operations faster

Revetment along slope of river bank. Final riprap covering traditionally placed at top of finished mat is not yet in place

process, and that in turn has created the necessity of a more rapid delivery of units to mat boats. This need was met by replacing the slow swing-around cranes that delivered one unit at a time to a type that lifts, conveys in a straight line, and lowers two mats simultaneously. The elimination of the swing action has improved the safety performance of the revetment process as well.

A significant contribution made by the Vicksburg District in revetment methodology was the development of the only indoor mat-casting plant in existence. Conceived by Vicksburg's former District Engineer, Lieutenant Colonel George F. Dixon, Jr., and developed by the District's personnel, the plant was put into operation at Greenville, Mississippi, in 1956.

Traditionally, concrete mats for the Mississippi River banks are field cast—that is, they are mixed, poured, and formed in the open at one of six locations scattered along the Mississippi River. However, field casting cannot be done satisfactorily when the weather is too cold or wet. By contrast, the Greenville facility was capable of operating regardless of the weather because the entire operation was indoors. Due to the shear size of the revetment program, the savings have been tremendous over the years since the plant was established.

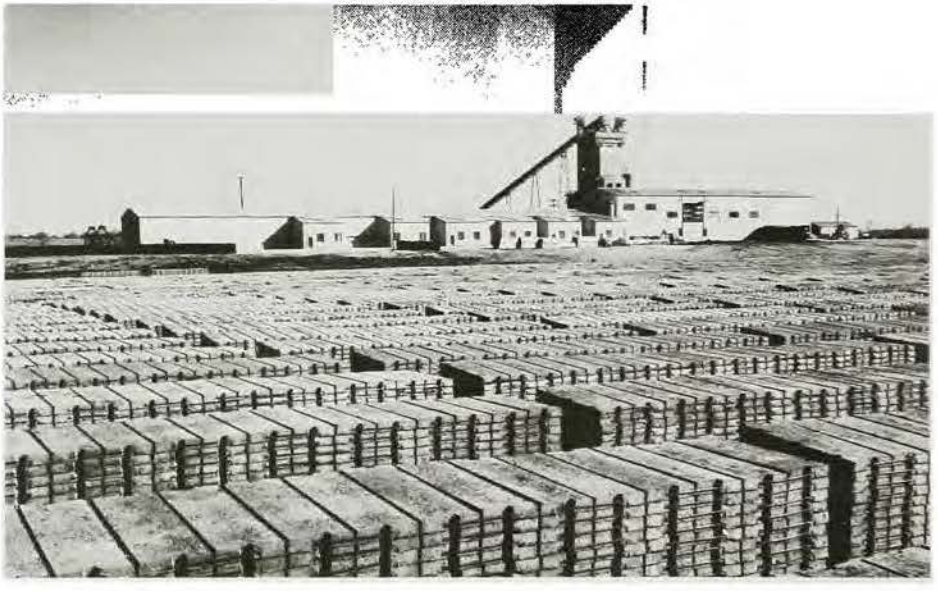
The year 1976 marked a turning point in the mat-casting process, however. The major part of future revetment construction has moved far downstream of the Greenville casting plant. The costs of transporting mats between the plant and the revetment sites were so heavy that they offset the savings that the plant generates. For the first year since the plant's construction two decades ago, it was not used, and it is not anticipated that the plant will be used again.

The technological progress made by the District in the revetment process has been termed revolutionary. A surface comparison of the first revetment activities in this District to the speed and precision with which the work is performed today seems to indicate that the term revolutionary is appropriate. In actuality, however, evolutionary would be a more descriptive term. Today's end result has been achieved only through long years of experimentation in which very little input has come from outside the Corps or from outside the District.

Dikes represent the second feature of the Mississippi River Improvement Project that presently plays an increasingly important role. Between the bends of the Mississippi, there are stretches of river in which the channel actually crosses from one side of the river to the other. At these points, the flow spreads over a large area and the water depth is shallower. From the earliest years of the District, some forms of dikes (sometimes called wing dams) have been used to realign rivers, but these early forms were never suitable for use in the strong currents of the Mississippi.

Vicksburg's Engineers, in recent years, have placed increasing importance upon the value of dikes. Used in combination with

The mat casting field at Vidalia, Louisiana



The automated mat casting plant at Greenville, Mississippi, is no longer in use

revetment, dikes can train the river's flow in the proper direction, prevent undesirable channels from developing, and help the river to maintain widths and depths adequate to carry flood flows and river traffic. In their efforts to develop an efficient dike for the Mississippi, the Engineers have experimented with a variety of designs and materials, including old automobile bodies.

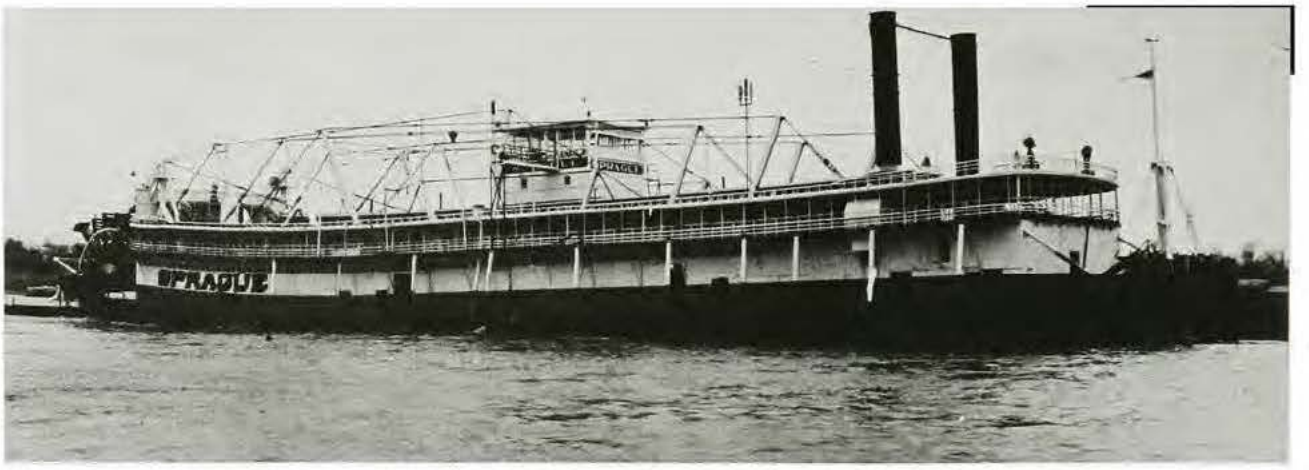
Initially, dike construction in the District utilized timber pile dikes that required timber piling, lumber, water, and riprap (stone pressed through a rock crusher). By the 1960's, a stone dike system was developed which proved to be the most efficient and economical. This process utilizes quarry-run stone, eliminating the need for machine processing and lumber mats, and reduces the need for timber piles. Basically, the modern process uses three pile clumps, with 200- to 250-foot centers along a center line, for the alignment of dikes. However, the dike construction program is not as advanced as the revetment program, since the latter was initiated many years before dikes were accepted as a useful tool. The high cost of both types of work, and

Experimental dike construction using junked automobile bodies

limited funds, make it impossible to "play catch-up" in the first few years.

A third traditional and still important feature of Mississippi River improvement is dredging. Here again, the equipment used is far superior to that with which the early Engineers performed this work. Electronics and automation have penetrated the dredging industry in the form of electronic sounding devices, gyrocompasses, and laser beams. A modern cutter-head dredge with discharge pipes 30 inches or more in diameter carries a price tag of several million dollars, but the work load it carries is equally tremendous. Maintenance dredging in the District for the fiscal years 1974 and 1975 amounted to 15 million and 3 million cubic yards of material, respectively.

Modern dredges, although expensive to operate, keep the channel open to billions of dollars in commerce



The record-holding Steamer Sprague, *which also burned in 1974, once was permanently tied up at the Vicksburg waterfront, a constant reminder of the hilly city's dependence on river trade*

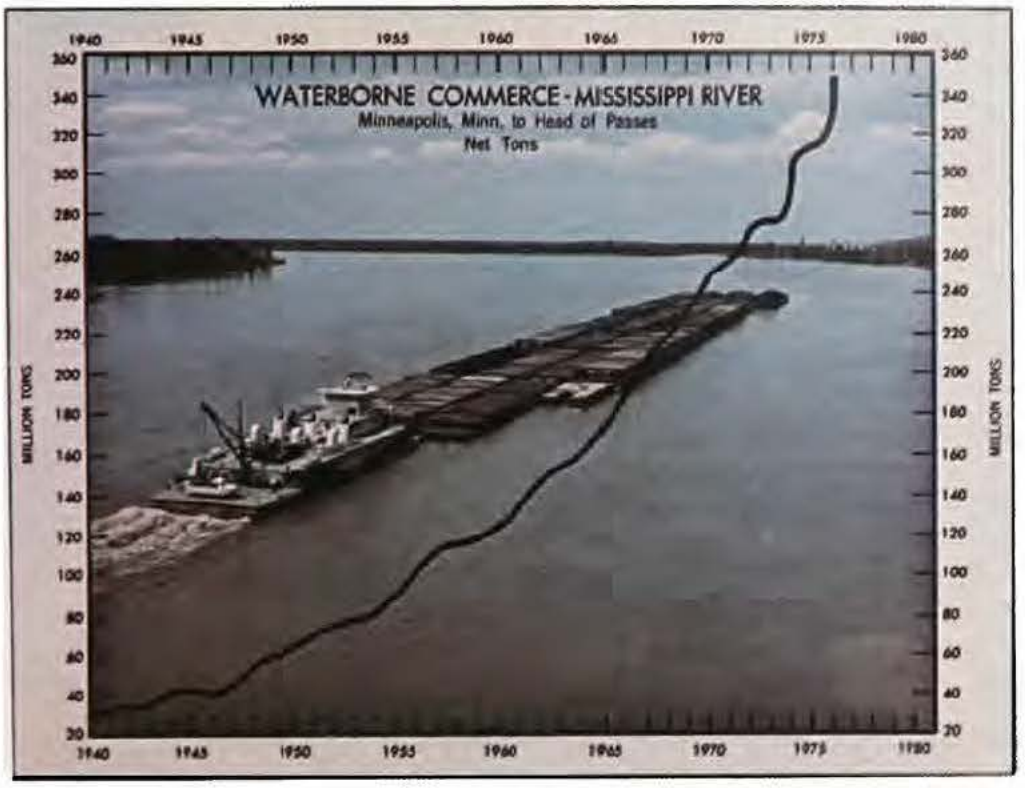
PORT AND HARBOR IMPROVEMENTS

The steamboat era on the Mississippi is usually envisioned as that river's commercial heyday. It is a romantic concept but not necessarily a valid one. The great railroad era of the late 1800's did rob the rivers of some of their lure—and much of their business—but over the decades the two modes of transportation have developed a definite pattern of complementing and augmenting, as well as competing with, each other's services.

The rebirth of river transportation became noticeably obvious during World War II. As the other areas of the transportation industry were hardpressed to meet increased freight demands, the Nation's shippers turned to the inland river system again. Commerce on the Mississippi boomed as heavy bulk commodities—especially oil, sulphur, and gasoline vital to the war effort—moved through the Mississippi's channel. Nearly 4000 Navy and Army craft built in inland shipyards used this river as their outlet to the sea. Establishment of the Federal Barge Line strengthened the commercial growth of the Mississippi, and subsequent expansion of river commerce has continued at a steady uphill rate. For the 10-year period from 1956 to 1966, for example, there was an 86 percent increase in commerce on the Mississippi River between Minnesota and the Gulf.

The effect of this commercial growth upon the Vicksburg District has been significant.

New port facilities at Vicksburg Harbor provided more jobs and added a chance for industrial and agricultural growth



The development of the Mississippi Delta as a "breadbasket of the world" has been accompanied by considerable exportation of such agricultural food products as rice and soybeans. To handle the increased activity, major port cities in the District have modernized and expanded their port and harbor facilities, and the assistance of the Corps of Engineers in these improvement works is a factor which all seem to expect and value. The services rendered have ranged from economic evaluations to actual dredging.

The Vicksburg Harbor Project provides a relatively typical example. Area leaders first conceived the project as a means of providing waterside industrial sites to enable the region to take advantage of the more economical water tranportation offered by the Mississippi River. A preliminary economic evaluation was made of the proposal by the Corps, and it was projected that 25 years of full-site occupancy would produce a benefit-cost ratio of 3 to 1.

After Congressional authorization was obtained, the Vicksburg Engineers dredged a slackwater harbor channel and used the dredged material to form a crescent-shaped, flood-free, industrial fill of 245 acres. The total cost, at its completion in 1961, was $5 million, with local interests shouldering 6 percent of the burden, primarily for rights-of-way and relocation costs. Subsequent improvements by Warren County have topped $2 million and include a modern public terminal. The value of the work has proven itself many times over. In 1958, for example, the unimproved harbor handled 800,000 tons of freight. In 1976, waterborne tonnage through the improved harbor almost reached the 3-million mark.

MISCELLANEOUS IMPROVEMENTS

A century ago in the Vicksburg District, the bulk of the work load centered around snagging and clearing. Today, these two activities play a very minor role, relatively speaking. As a direct result of the Corps' bank stabilization program, snagging operations are virtually unheard of on the Mississippi River. Likewise, the reservoirs built on the tributaries have reduced the amount of drift which once presented such a problem. Difficult pockets do remain, primarily in the Ouachita-Black River system and the Yazoo River system. Unusually low water in the summer of 1976, which followed 3 years of extremely high water, has caused an unusual amount of bank

The Charles H. West *of the paddle wheel era*

The Lipscomb *in use today*

caving in these two river systems. As a result, snagging work this year has increased considerably.

The methodology and equipment used by the snagging teams on the Yazoo this year are far removed from those with which Major Willard tackled this river in the late 1800's. The old-fashioned snagboat is obsolete, replaced by a general-purpose boat. Steam engines have given way to diesel power. The labor gangs, sometimes 50 men strong, which hacked their way through marshy stands of willows have now disappeared. Twentieth century society has seen a decrease in the labor supply as an increased percentage of the work force developed skills and the remaining unskilled laborers sought safer and less demanding jobs.

Chemical control has filled the void left by the shrinking labor force, but again increased knowledge and skills have been needed to develop the new program. Selected herbicides must be highly effective to kill the plants on which they are applied. But, at the same time, they must meet rigid safety requirements. There must be no adverse, or even long-term, effect on the productivity of the soil; they must be nonvolatile; and they must present no toxicity problems to the workers or to wildlife.

Within the past decade, the Vicksburg District also has succeeded in solving a problem that has plagued engineers in the valley since Henry Shreve first began to remove snags from the Mississippi. Tree trunks and stumps which could not be pulled from a stream could only be sawed off above

A brush control party battles to keep drainage channels open

water level. The channel-clearing parties normally worked at low-water levels, but the sawed-off snags still remained high enough to spear boats that passed over when the water level hovered just above the snag.

For years, the resident engineer at Blakely Mountain Dam on Lake Ouachita had been troubled by this problem and sought a solution. His concern intensified when a close friend was killed in a boat accident in the Mississippi that was caused by such a snag. After 12 years of study and experimentation, the engineer succeeded in the development of an underwater saw. Attached to the bottom of a barge and powered by remote control from the barge's deck, the new saw has made it possible for the District's Engineers to sever snags 5 feet below the water level.

Mapping and surveying remain an indispensable part of the District's flood-control and navigation improvement works. These two activities have always preceded any work performed by the Engineers, and the pattern still holds valid. Many of the early failures in flood control, so earnestly undertaken by private interests, were caused as often by the lack of adequate information as by the lack of skills and funds. When the Federal government assumed responsibility for flood control in the wake of the 1927 flood, it began vast programs of surveying and mapping. Initially, 98 quadrangles were assigned to the Vicksburg District. By June 1975, 195 quadrangles had been completed and

Since the days of the early Engineers, the Mississippi River has been watched, measured, and studied

Survey techniques are the least changed of the engineering techniques. Even George Washington would know what is happening here

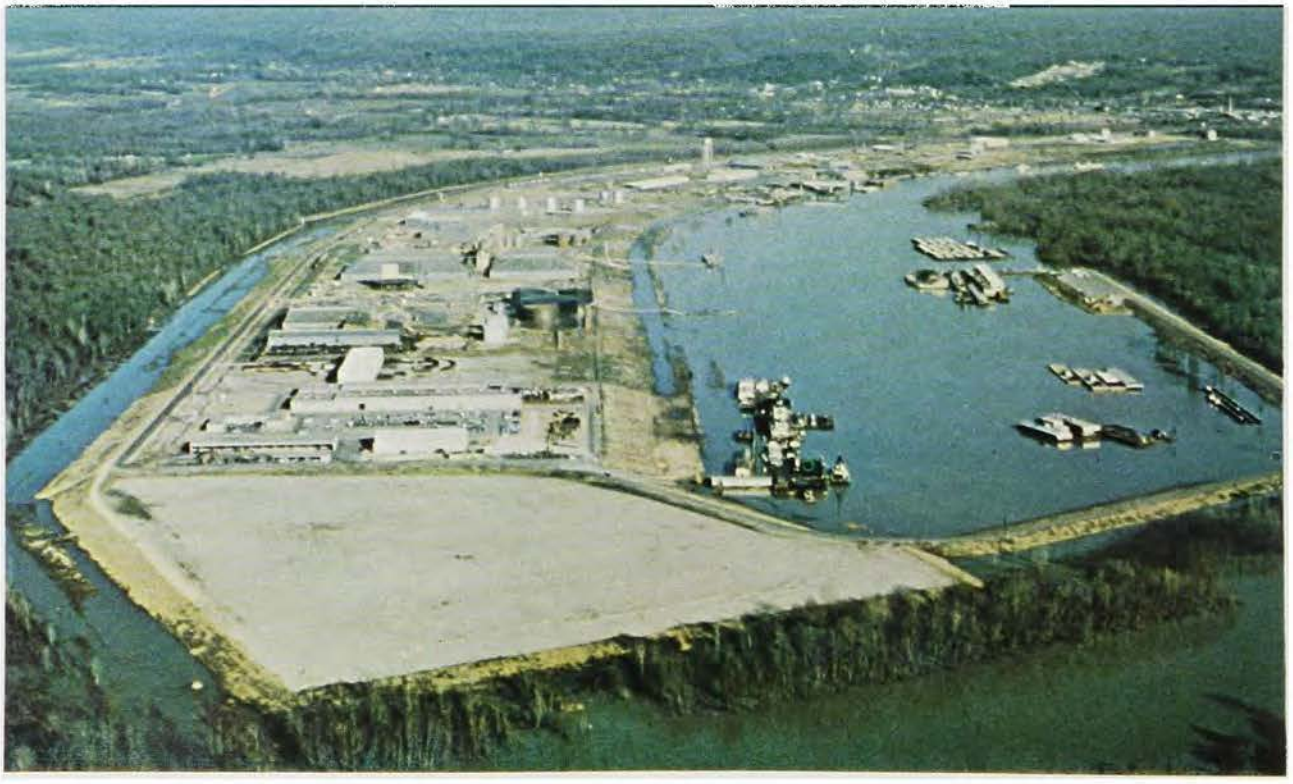
are currently undergoing revision and updating by the District in cooperation with the United States Geological Survey.

Modern technology has affected mapping and surveying operations as extensively as it has other aspects of engineering. The days of hiking into areas inaccessible by boat or horse, the days of camping for months in the midst of insect-infested swamps, and the days of half-paddling, half-dragging boats through shallow, overgrown streams are gone forever. Riding in the stern of a rowboat with a lead line and taking soundings while rowing back and forth across the stream is a skill of the past. Today's cartographers and surveyors use electronic devices and aerial photographs. Soundings are taken in a survey boat that zips along at 30 miles an hour. An electronic fathometer transmits all data into a computer and points are plotted at the time each spot in the river is reached. Such technological advancements enable the District to do its work more satisfactorily, more quickly, and more inexpensively.

An indispensable aid to the District in this last half-century of development has been its rapidly expanding communications system. The radio was first introduced into the District in the course of the flood fight of 1927. The first office set, built by the Corps in St. Louis, was an extremely unsophisticated model by modern standards, but it was destined to revolutionize the communications problems constantly plaguing the District. Keeping tabs on various crews scattered over an area in excess of 50,000 square miles had always been a perplexing but necessary responsibility. Any necessary contact with the crews required special messengers and considerable time. With the addition of radio receivers and transmitters to each workboat, instant communication has been made possible regardless of location.

The Vicksburg District's first radio room prior to World War II was not much more elaborate than today's citizen band units

This radio component system features mobile dispatch and telephone patch, telegraph, and the capability to tune the receiver-antenna automatic caller over 6 miles away. This setup, of which there are three, was built in the District's Electronics Shop

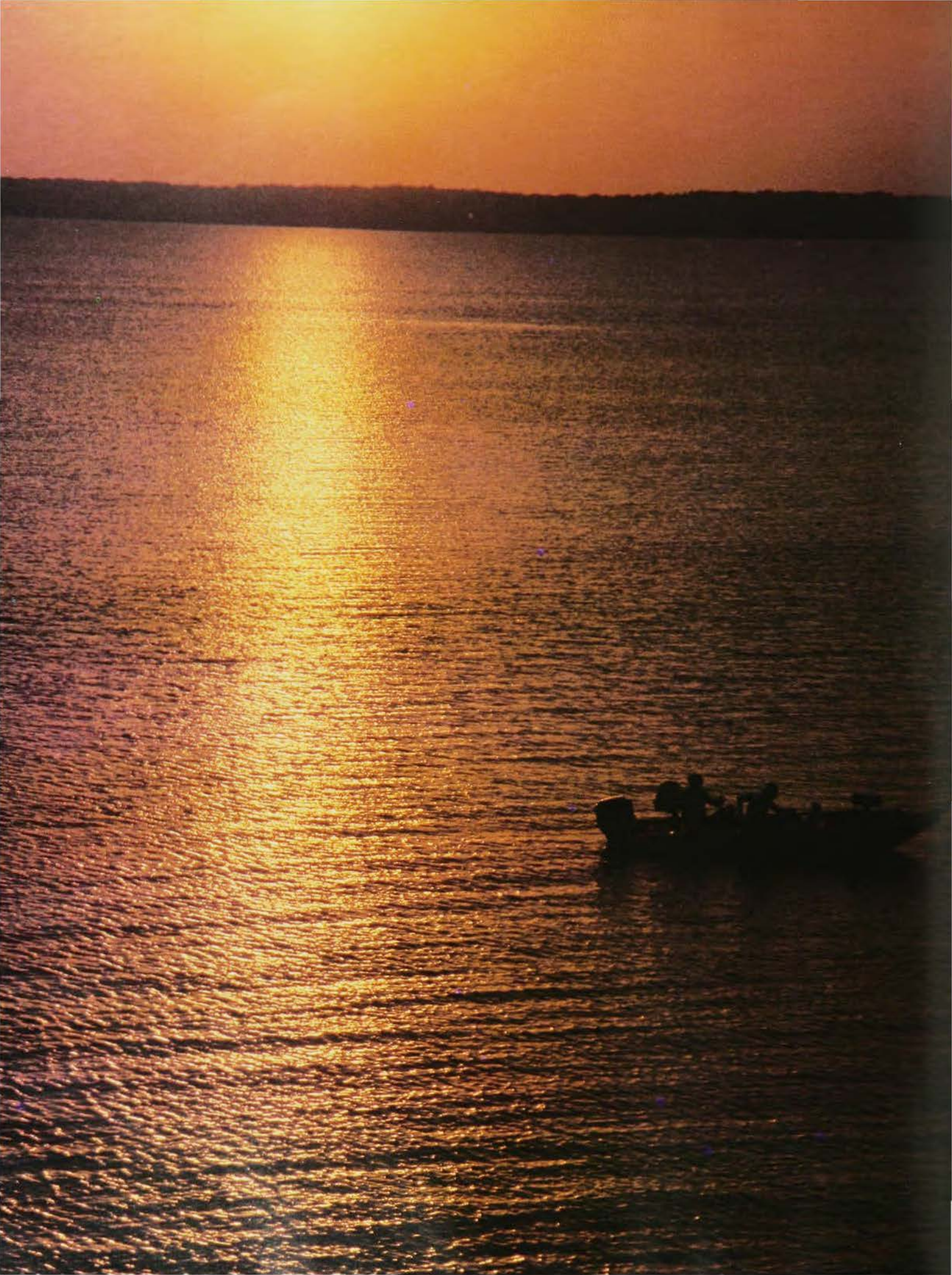


The Vicksburg Districts' fleet area grew up at the riverfront along U. S. Highway 80 at Vicksburg (above) and was expanded in the late 1960's to include the Plant Branch, drydock areas, and modern office space. The new fleet and tie-up area (below) is located at the west end of the Port of Vicksburg, about 2 miles north of its wartime site

In the years that have followed, the first "radio room" (which was located in the present elevator shaft of the Mississippi River Commission Building) has grown to an expansive and highly sophisticated Communications Center. The day-to-day savings in time and money that instant communication provides are too infinite to be calculated on modern projects that involve such astronomical investments. But the greatest value of the system is undoubtedly felt in those emergency situations when up-to-the-minute weather broadcasts, precise tracking of hurricanes, and total coordination of manpower often mean the difference between life and death for vast numbers of people.

Fifty years have passed since the advent of the tragic superflood that paralyzed the Nation. Those five decades, indisputably, have been the most complex experienced by the Vicksburg District, but they have also been the most successful. The earlier piecemeal approach to water resources development in the midvalley (i.e., you handle flood control and we'll take care of navigation) had proven itself disastrous. Coordination and leadership were the two factors vitally needed to achieve maximum development of this Nation's water resources. The national decision to accept responsibility for valley floods in 1927 and 1928 removed the last major obstacle to the coordination of river management works. In the half-century since, the United States Army Corps of Engineers has proven conclusively that flood control, navigation improvement, and social expansion are all inseparable entitites.

However, the success which the Engineers have achieved in the areas of flood control and navigation improvement has not lessened the Nation's need for their services. As this relatively new country is tamed and man grows further away from the day-to-day fight for survival that once preoccupied him, a growing emphasis upon the quality of life has created new and expanding missions for the Army Engineers.



CHAPTER VI
A NEW AND EXPANDING MISSION

The wind sings of a breed of men who
have gone forth to fight
For a clean sky and a free land and a
star-silent night.
The wind sings of fighting men, men who
dream the Dream.

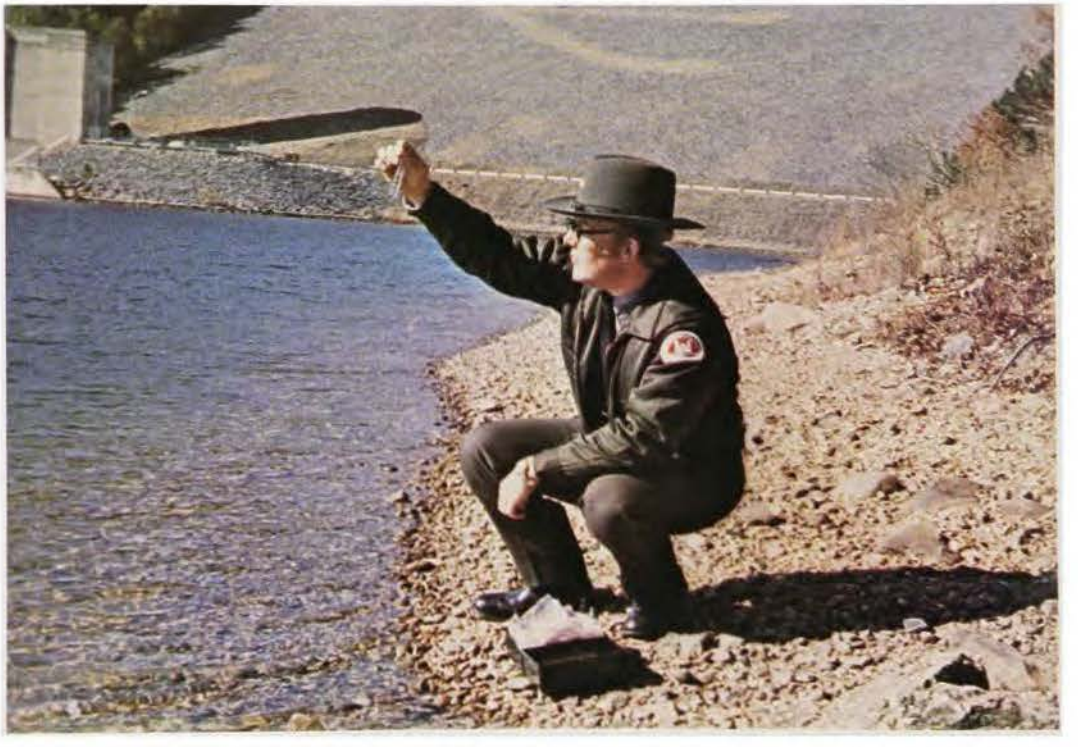
Hal Borland

As early as 1914, the demand for comprehensive planning of America's water resources began to encompass aspects even broader than flood control and navigation improvements. In the years that followed, it became still more apparent that the Nation's waterways could serve or damage public interests in many ways.

Across the broad expanse of twentieth-century America, there has stretched arid lands that could be settled if water could be channelled to them. Green belts of forests once indiscriminately cleared have become natural treasures to be preserved. As the Nation has expanded, its need for water power has increased tremendously, and its streams have

As industry continues to flourish, pollution continues to be a major problem in the world of economics and ecological balance

Wetland areas and marshes that offer excellent habitat for wildlife are another concern the Corps may have to face in the near future. The Corps' permits program is already geared to protect these areas



Water quality is a concern of environmentalists, naturalists, and the Corps of Engineers. Field personnel at the Vicksburg District's lakes monitor water quality

become choked with human pollution. Men have invaded—and spoiled—vast stretches of the natural habitat in their determined quest for a better abode; and those successful in fulfilling the Great American Dream have done so only to find that there are fewer unspoiled retreats in which they can enjoy their increased leisure.

By the end of World War II, a new breed of Americans had begun to fight for public works inconceivable to earlier generations. Varied recreational facilities for a balanced and healthful use of leisure time, environmental protection to preserve the natural heritage of the Nation, and immediate, unlimited, and inexpensive energy to power the machines of a highly developed society—all became major challenges in mid-twentieth century America.

A clash with the traditional demands of the public was inevitable as spokesmen for the new issues voiced their concerns and sought rectification. Responsibility then fell upon the Corps of Engineers, the Nation's expected leader in public works, to strike an effective balance between those who fight to preserve natural resources and those whose life and livelihood depend upon flood control and navigation.

For the United States Army Corps of Engineers, the conflict in ideology has presented unparalleled and multifaceted opportunities. Meeting the challenge required intensive reevaluation of traditional standards and extensive development of new procedures, and it has offered boundless potential for significant contributions to the structure of American society. Yet, at times, the new missions have seemed to be thankless tasks.

In the past decades of reevaluation, the

DIRTY OLD MEN

Corps of Engineers has been labelled an environmental villain, a bureaucracy dependent upon the dams it builds to "justify its continued existence." Its channelization projects have been called "gutterization." Sportsmen have increasingly complained that turbidity from agricultural runoff and dredging work has destroyed their favorite streams for fishing. Projects of considerable urgency have been halted or delayed because of the possibility of impact upon the natural environment. At least one national celebrity has lambasted the flood and health control work of the Engineers with the incomprehensible contention that "It would have been better to let nature take care of the population balance through floods and plagues."

John W. Brennan

Felix R. Garrett

In some respects, the endeavors of the Corps have earned at least part of the criticism that has been directed toward it, and the Vicksburg District has been no exception. "Certainly, we have made mistakes," District Engineer John W. Brennan told a Monroe gathering in 1970. But Colonel Brennan also pointed out that "We have tried earnestly and honestly to make the proper choices and respond to the wishes and needs of the people within the authorities granted to us."

Much of the difficulty encountered by the Corps has been a direct result of the tumultuous changes in society. Engineers in 1930 could not have predicted with any degree of accuracy the current demands upon the Nation's water resources for recreation, fishing, wildlife, pollution abatement, and other uses. The impossibility of anticipating all possible ramifications of new methods and demands has occasionally resulted in unfortunate choices of technological alternatives. Yet the Vicksburg Engineers have conscientiously sought to correct unfavorable results wherever possible.

Concurrent with these problems is the tenuous necessity of weighing benefit against benefit on the delicate scale of human needs. Channelization in certain areas of Arkansas, for example, has been deemed vital by those who live under the threat of flooding. Yet, the resulting drainage decreases the water level and kills the region's cypress and hardwood trees. Environmentalists deplore the demise of natural and scenic streams. On the other hand, if the Corps of Engineers ceased their improvements, agricultural interests and residents of alluvial lands would suffer enormously.

In discussing the Corps' position, Vicksburg's former District Engineer, Colonel Felix R. Garrett, pointed out to a Greenville audience: "There is no question but that there are trade-offs.... You can't have your cake and eat it too." But Garrett also expressed the opinion "There's no reason why the public shouldn't get as much cake as possible and trade off as little as they need in order to implement necessary solutions."

In their efforts to balance trade-offs and better meet the needs of the public they serve—in essence, to meet the demands of their new

A new type of channel clearing on Ascalmore-Tippo Bayou in north Mississippi which, unlike previous efforts in this area, left cypress trees and other larger species.

and expanding mission—the Engineers have brought a host of other professionals into their organization: biologists, environmentalists, city planners, ecologists, landscape architects, archaeologists, and wildlife consultants. "With this kind of approach," a Vicksburg newspaperman predicted, "surely reasonable people can work out a reasonable balance between the demands of ecology and economy."

THE NEW CORPS

It was in the 1950's that discerning members of the press began to publicize "the New Corps." Former Vicksburg District Engineer, Lieutenant General Samuel D. Sturgis, Jr., assumed the office of Chief Engineer early in 1953, and under his astute and charismatic leadership the Engineer organization made significant strides. Priorities were revamped to accommodate more small, local works, and to incorporate a greater geographical balance into the utilization of funds. A Policy Planning Section

Samuel D. Sturgis, Jr.

District archaeologists brush sediment away from an unearthed find

During excavation of a borrow pit, a Corps contractor found the remains of a ferry believed to have sunk in the old bed of the Mississippi during the 1850's. The site was 2 miles from the present river bed

The Tensas River is typical of many streams in Arkansas and Louisiana which retain their natural beauty

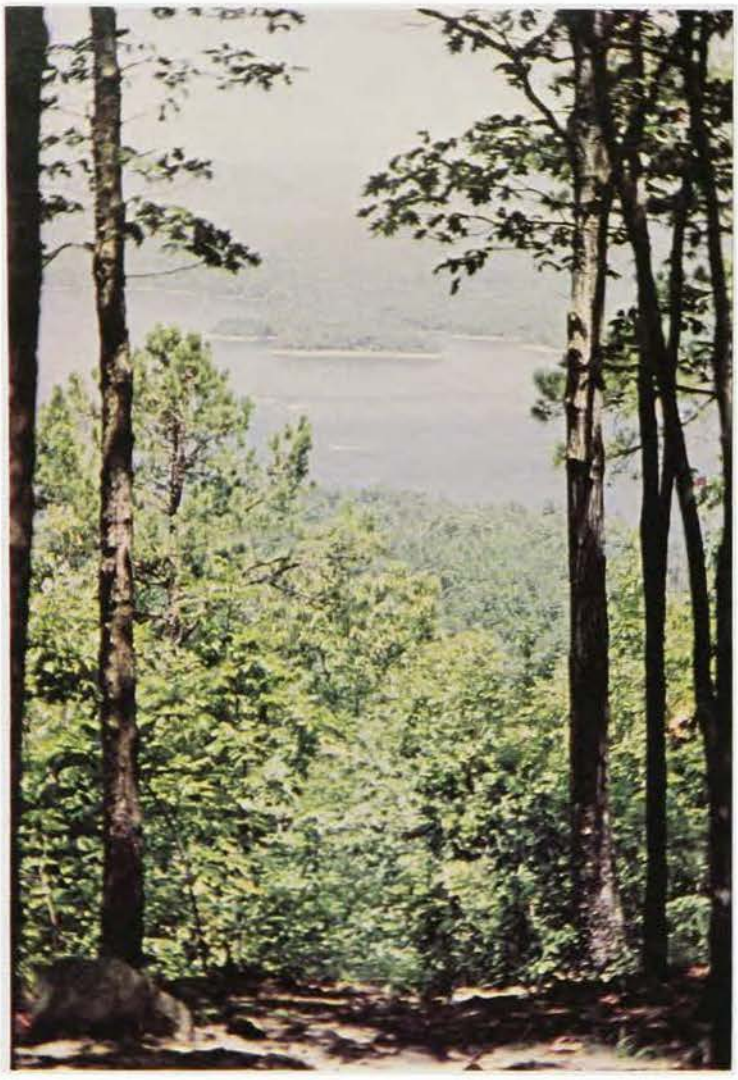
was set up in the Chief's office to generate new ideas and analyze their long-range impact. The new Chief discussed his concerns more openly with the public and encouraged feedback. By the end of his 3 years of leadership, the Corps of Engineers was earning public praise for its "fresh views" and "new outlook."

Subsequent leadership within the Corps organization has continued the spirit of renewal initiated by General Sturgis, within the authority granted to them by Congress. Short courses in environmental resource analysis have fostered an ever increasing awareness of esthetic and cultural values in water resource planning. A wider range of alternatives has been required in project studies and proposals, with more emphasis upon nonconstruction alternatives. Backlogged projects now are reevaluated before final implementation to determine present feasibility. An increasing amount of reliance is placed upon contract work, to provide the public with a greater range of expertise, to generate the economy of the private sector, and to prevent unnecessary expansion of the number of employees on the public payroll. In addition, a series of Congressional acts has entailed key changes in the organizational structure of the Corps while greatly expanding its mission.

RECREATION AS A PROJECT PURPOSE

The recreational use of Engineer projects began as an incidental amenity, not as a planned purpose. When the Vicksburg District constructed its first reservoirs in the 1930's, the Corps, as well as the public, viewed these only as flood-control measures. Inevitably, their well-kept banks attracted picnickers, and fishermen found favorite "holes" within the lakes—a phenomenon that was being experienced nationwide at almost all of the Corps locks, dams, and reservoirs.

In 1944, with the authorization of Congress, the Corps of Engineers responded to the new public trend. Recreation was recognized as a worthwhile public need and included as a planned feature in all feasible water resource development projects.



Although man-made,
the Arkansas lakes add to...

...the scenic beauty of the Ozarks and
other surrounding mountain chains

Within the Vicksburg District, the recreational use of Corps projects has grown at an astounding rate in the past two decades. The Recreation-Resource Management Branch established in 1971 is responsible for the management of 134 sites that cover 400,000 acres of land and water in three states. The reservoirs in the District are well-stocked with bass, brim, catfish, and crappie. Facilities abound for swimming, boating, skiing, camping, and picnicking, with lodges, trailer parks, and bathhouses, sandy beaches, and lovely, secluded inlets and coves. Summer camps have been organized at the sites by various youth organizations.

In the present decade, the varied recreational facilities offered by the District have recorded an attendance average of some 14 million visitor-days per year—a figure considerably higher than the District averages for the Corps as a whole.

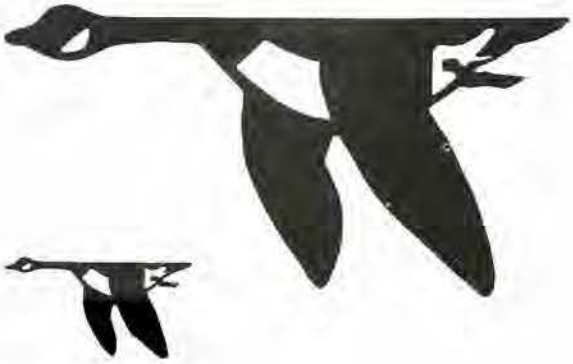
The popularity of this District's recreational facilities reflects the care of the Recreation Branch in all phases of the development and maintenance process. Each proposed project is closely analyzed for recreational potential, and a recreational masterplan is prepared at the start of each appropriate project design. Participation by state and local agencies in the construction, operation, and maintenance of recreation facilities is strongly encouraged to strengthen the idea that the project belongs to the *people.* Indeed, local participation in one of various forms is normally required by law. Enthusiastic and dedicated rangers assume authority for the maintenance of order at each Corps-operated site. Vandalism is only a minor problem, a boon for which the Recreation Branch gives credit to the cleanliness and modernity of the facilities and the sociable supervision of the rangers.

FISH AND WILDLIFE CONSERVATION—AN OVERVIEW

Closely related to the recreational designs of the District is the Corps' complex program of fish and wildlife conservation. In the 200 years of Engineer activity in America, few—if any—of its works have enjoyed such a considerable degree of public input, and few areas have presented as many challenges.

The nineteenth century, and almost half of the twentieth, had passed before public interest in fish and wildlife conservation had

As habitat for waterfowl disappear, the District tries to provide a substitute for wood duck at DeGray Lake



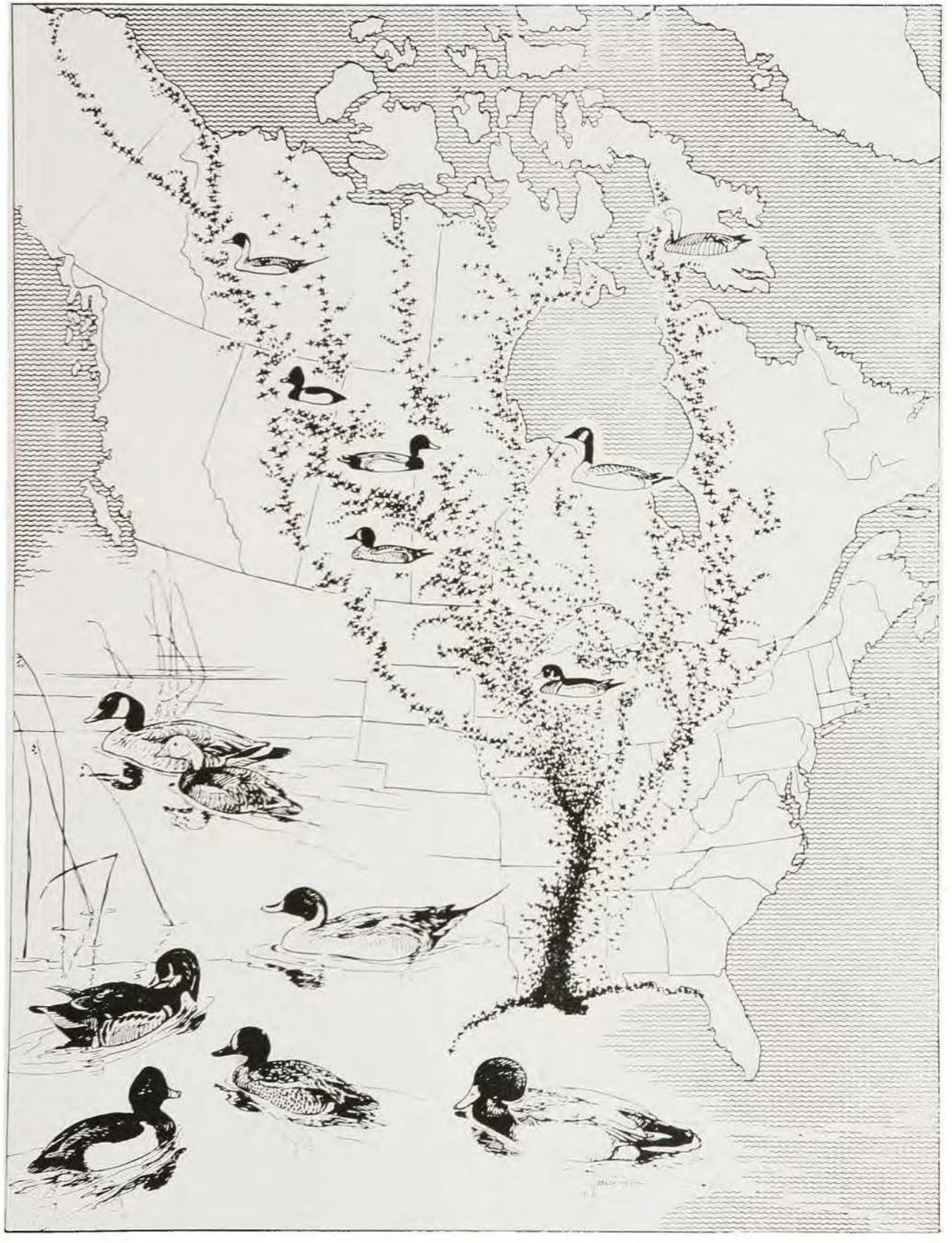
any great impact upon the Corps of Engineers. Those who needed protection from floods as well as routes to market still outnumbered by far those who had begun to worry about natural habitats and wildlife resources. The year 1958 marked the turning point. In recognition of a reversing public sentiment, Congress decreed in that year that any construction agency, including the Corps of Engineers, should henceforth consider the consequences to fish and game in certain proposed water resource developments and must coordinate their work with the United States Fish and Wildlife Service as well as the comparable state agencies.

In 1969 a new Congress again addressed the question of environmental protection and took even more drastic action. The resulting National Environmental Policy Act (NEPA) is certainly the most significant piece of legislation on this subject, and it is considered by many to have had more impact on Corps planning than any other legislation. Effective January 1970, Corps projects and those of other construction agencies must be preceded by environmental impact studies. In complying with the new legislation, the Corps has integrated input from these studies into all planning documents on each project from its beginning to its end; and in the opinion of at least one official, it has set the pace for all Federal agencies in applying NEPA.

The issue of environmental protection has had a tremendous impact upon the work of the Vicksburg District; indeed, the largest branch in the District's Planning Division is the Office of Environmental Resources. The degree to which the Vicksburg District has become involved in the conservation of natural resources has been inevitable. The District spans a large portion of the historic Mississippi Flyway for migratory birds. Its acreage encompasses vast stretches of low-lying fields, marshes, and hardwood stands which are excellent habitats for fish and wildlife. Its perennial, historic flooding has provided an ideal environment for wildlife.

Yet, the recurring floods once hampered the economic development of the region despite the unsurpassed fertility of its soil. Flood-control measures introduced at the request of the valley population drastically improved the quality of life, but these measures simultaneously robbed the region's wildlife of many of its natural habitats and have been slowly choking others. Improvement projects of the District have taken a lot of lands formerly useless and made them more useful. They opened new and profitable, extremely fertile, Delta lands for hill farmers who had raised more soil erosion problems than crops on their scrubby tracts. Yet, on the other side of the spectrum, this agricultural development created environmental problems that many Americans have considered to be even more serious.

MISSISSIPPI FLYWAY



In central Louisiana, the Corps worked with the locals to put a levee through a church cemetery. The tombstones were surveyed and raised to the height of the levee, directly above their original location

ENVIRONMENTAL IMPACT STUDIES

In response to the new focus upon environmental protection, the Planning Division of the District closely follows a five-step procedure carefully designed to generate optimum public input on this subject.

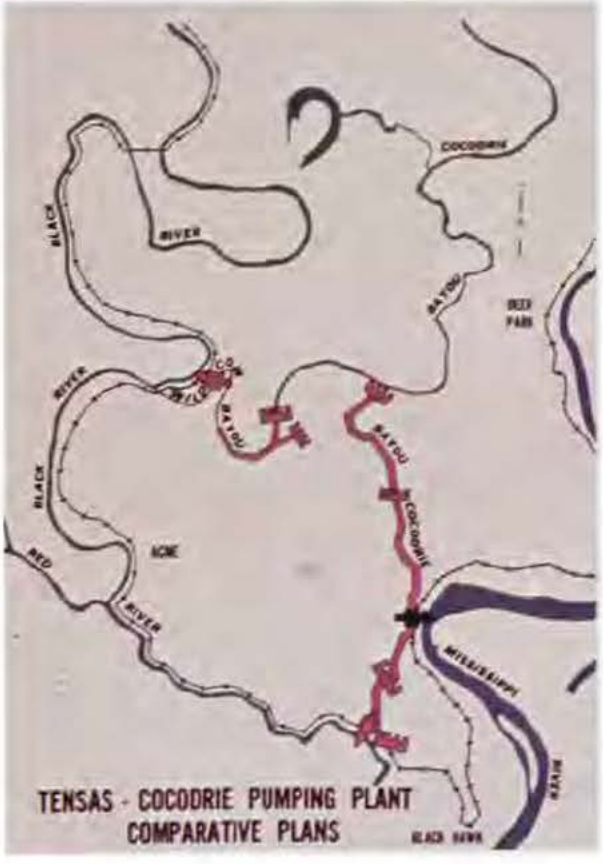
First priority is given to the preparation of an environmental impact statement which considers all effects of a proposed project upon cultural and natural resources, as well as a host of more intangible esthetic values.

In the second stage of environmental planning, the impact statement is circulated through all interested agencies—Federal, state, and local, private as well as governmental. Their comments are requested, along with those of the President's Council for Environmental Quality. After a 45-day minimum waiting period, all comments are evaluated and the impact statement adjusted as necessary, with specific address, wherever necessary, to each comment that requires an answer.

In the final stage of the process, the revised statement is filed with the Council; those who commented on the earlier draft have an additional 30 days for review of the final statement. Normally no modification of the final statement is necessary.

The environmental impact studies generated within the Vicksburg District have encompassed some of the largest studies produced within the Corps. The Vicksburg Engineers were assigned the responsibility for conducting the impact study for the channelization of the mainstem of the Mississippi River from Cairo to the Gulf, although the project actually encompassed several districts and came under the jurisdiction of the Mississippi River Commission. In the conduct of this study, as with most Corps studies, the preparatory work was done under contract, with experts from the private sector providing general background information, the environmental inventory, and an assessment of project impact, while the District remained responsible for supervision and final preparation of the statement.

An encircling levee around Concordia Parish, Louisiana, to provide protection from frequent overflow from backwaters of the Mississippi and Red Rivers was authorized in 1941. The authority included a gravity floodgate to evacuate drainage of Bayou Cocodrie when Red River stages permitted. The project was completed in the early 1950's. In 1965 pumps were authorized to reduce ponding levels in Bayou Cocodrie. Detailed planning for pumping facilities began in FY 1970. This involved delaying construction until the District's first in-depth study of the probability of the presence of rare and endangered species could be completed. The study revealed, to the satisfaction of the U. S. Fish and Wildlife Service, that the area was not the habitat of endangered species. The site for the pumps was subsequently moved to a location on Black River to reduce channelization requirements and lessen potential habitat damage.



After the passage of NEPA in 1970, the Vicksburg District contracted for an endangered species study which eventually confirmed only the presence of one such species, the American alligator, with a probable or at least migratory presence of the Southern bald eagle and a possible transit of the Florida panther. However, the mere existence of the species in that or any other region is not considered sufficient reason, by Federal policy, to abandon a proposed project; it must also be determined by the Department of the Interior and the U. S. Fish and Wildlife Service that the area is a critical habitat of that endangered species. As a result of environmental concerns, the site for construction of the Tensas-Cocodrie project was moved.

Outside the realm of wildlife conservation, the environmental impact studies also encompass yet another new aspect of water resource policy: cultural resources. From the archaeological standpoint, too much of the prehistory of the Mississippi Valley has already been destroyed; preservation of the remainder is imperative. Mounds levelled as nuisances by settlers and engineers of the past now must be left untouched; if necessary, even mainline levees must be realigned. Under current law, the Engineers are not only responsible for the preservation of every arrowhead unearthed but must also consider archaeological potential

Three endangered species have been considered in several of the Vicksburg District's projects...

the Southern Bald Eagle,

the American Alligator,

and the Florida Panther

as a key aspect of their environmental impact studies.

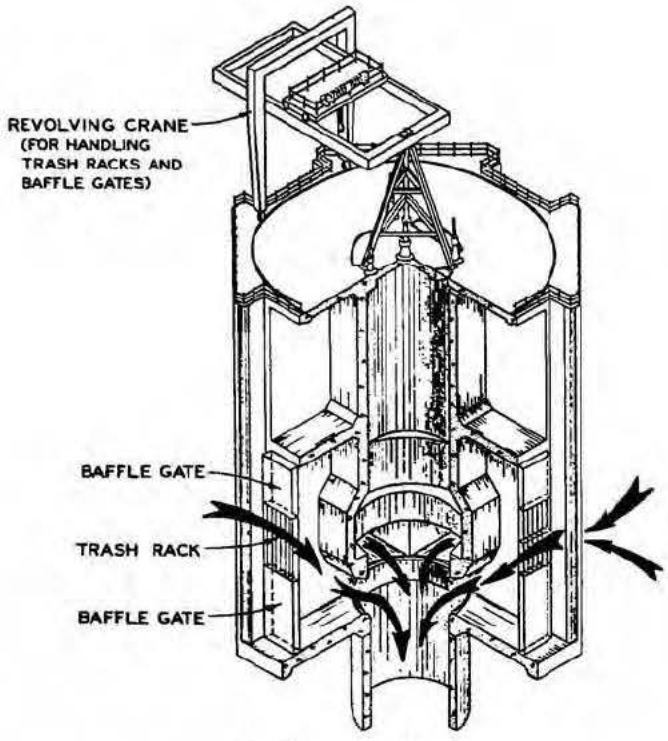
The requirements imposed by recent environmental impact legislation have posed tremendous challenges for the District's planners, but the necessity of the requirements is unarguable. The general spirit of those involved has been aptly put into words by one 20-year veteran of the District:

> *It's all in the best interests of the public—at least I hope it is in the best interests of the public. You know, our works are not Corps of Engineers projects, they are the people's projects—built and operated for the people, because that's who we are here to serve.*

DAMS VERSUS FISH: A CASE AT POINT

Even prior to the passage of NEPA, the Vicksburg District had become concerned with wildlife preservation, particularly aquatic life. The first reservoirs within the District, Sardis and Arkabutla, were shallow storage facilities. No detrimental effects on downstream fishing were noted as a result of this reservoir construction. As the Corps progressed to larger, multipurpose dam and reservoir projects, however, the results drastically changed. At Narrows Reservoir, serious effects on marine life resulted from the deep, forceful discharge of cold water.

Similar conditions to those at Narrows existed at the site of the third multipurpose facility proposed for the District, DeGray Reservoir on the Caddo River of Arkansas. From the initiation of design planning on this project, the inclusion of warmwater release facilities was required, and the assistance of



DeGray intake

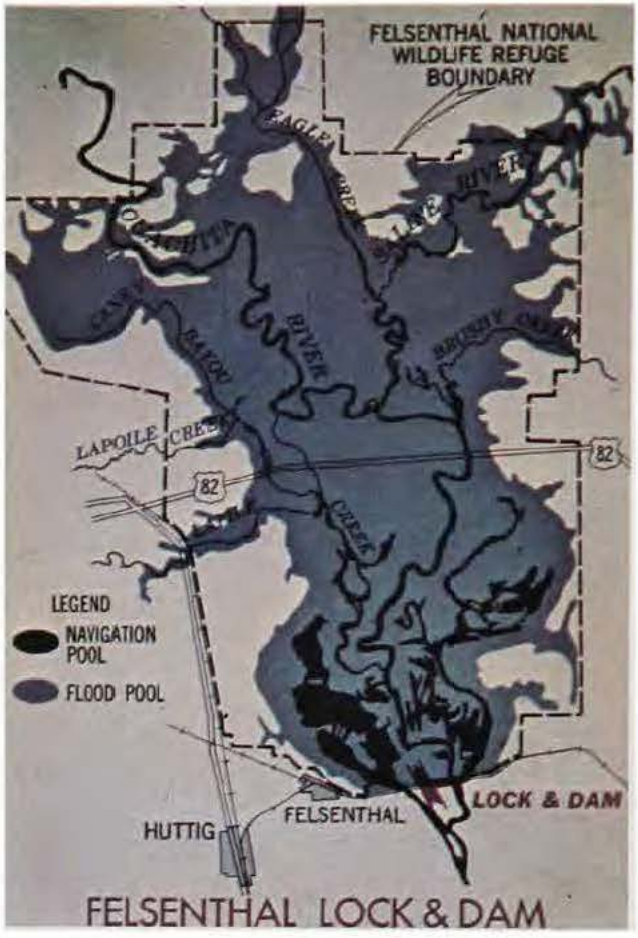
the U. S. Fish and Wildlife Service, the Arkansas Fish and Game Commission, and other interested agencies was sought in the development of the design.

Since water temperature varies at different depths, one solution is obvious: take the downstream discharge from that portion of the reservoir which has reached the desired temperature. However, since reservoirs are subject to fluctuations in water level, the solution is not as simple as it appears. Moreover, the removal or addition of water must be accomplished under precise conditions which do not impair turbine efficiency, and it must be economically feasible. The design ultimately developed was based upon those used at other Corps projects, wherein an intake tower is fitted with a cylinder gate to shut off water flow whenever desired, but with strategic modification to provide a versatile and practical system for choosing the level from which water is drawn.

WILDLIFE REFUGES

Within the past decade the Vicksburg Engineers have made significant strides in the effort to preserve natural habitats within the midvalley region. A primary feature of their wildlife conservation work has been the establishment of wildlife refuges. To date, four such refuges are in operation or in the advanced planning stage: DeGray Waterfowl Refuge in southwestern Arkansas, the Bayou D'Arbonne Refuge of northeast Louisiana, the National Wildlife Refuge in Arkansas, and the Hillside Floodway Refuge in Holmes County, Mississippi, and the authorized purchase of 12,800 acres of mitigation land in the Red River Backwater Area.

By far the largest and the most significant of these four reservoirs is the National Wildlife Refuge planned for the Felsenthal Swamp of Arkansas. In its unimproved state, the swamp

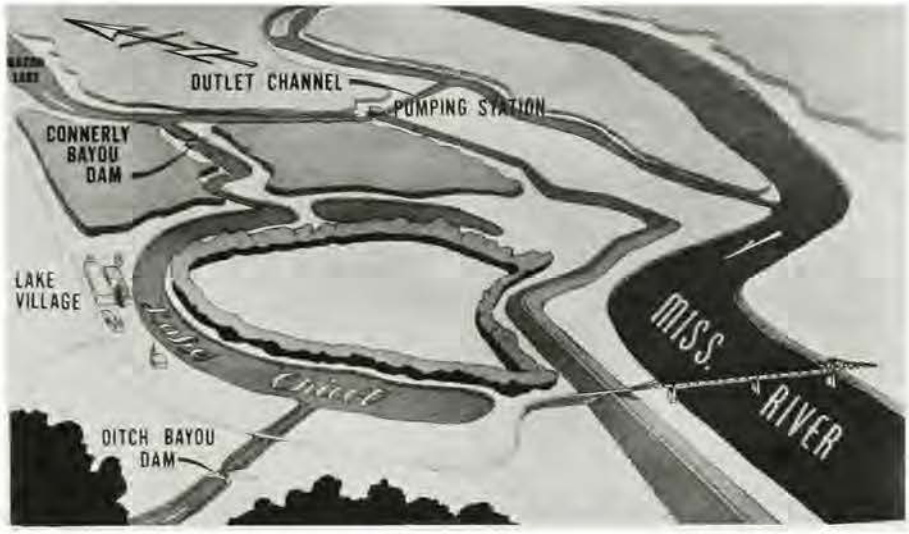


has been a natural wildlife habitat, a sump area flooded annually since time immemorial. Local wildlife associations had long sought to develop the recreational potential of the region, but lacked sufficient funds.

The selection of the Felsenthal region as a lock and dam site for the Ouachita-Black Navigation Project provided the impetus and the means for realizing the recreational potential of the swamp. The purchase of surrounding lands by the Corps was necessary to provide the required increase in the depth of the navigation pool, and the recreational use of that land was recognized as a natural outgrowth.

In the early planning stages on the lock and dam, representatives of the area wildlife associations broached the Corps with a request to combine the needs of navigation and game management. Only minor adjustments would be necessary in the planned regulation of the pool. The Vicksburg Engineers complied with this request and included a wildlife reservoir as part of their navigation project study. In the coordination of District studies with work of the U. S. Fish and Wildlife Service, the Service recognized the unique potential of the area and agreed to take into their refuge system the 65,000 acres of swamp to be purchased.

Upon completion, the project will be a model refuge of unusual expanse, with a variable-height weir which enables the Wildlife Service to hold the pool, in certain times of the year, at a minimum elevation of 65 feet. This reduced size of the lake will stimulate in-the-woods production of food material for waterfowl and wildlife. Moreover, the lake can be filled a month earlier than the region normally fills and can be held at optimum level for a month longer, thereby providing the extended fishing season desired by wildlife interests.



MITIGATION

The new ecological priorities established by Congress have necessarily required adjustments in some Corps projects planned and authorized, but not constructed, prior to the passage of NEPA. In other cases, environment-conscious engineers have recognized that some projects constructed prior to NEPA, and thereby not governed by the new regulations, nevertheless have some degree of detrimental effect upon the environment, and steps have been taken to rectify the existing situation.

Lake Chicot, an old oxbow lake in southeast Arkansas, has long been a famous fishing spot, popular for boating and a variety of recreational activities. Leisure cottages lined its banks. But, by the mid-twentieth century, the lake was almost dead. Its problems were not self-contained.

Upstate, decades before, residents of the low-lying Cypress Creek area had initiated improvement works to protect themselves from flooding. Historically, the creek emptied into the Mississippi River, and the levees constructed by private interests in the 1800's contained a gap that preserved that creek's opening. However, in 1920 the area drainage districts closed the gap and dug two lateral canals through higher ground in the years that followed to drain the Cypress Creek Basin. For several years the area drained as anticipated—until the flood of 1927. When the Arkansas River levee broke upstream in that year, a vast amount of water washed through the man-made channels and down into Lake Chicot; the channels were silted up and the lake began to fill.

The Cypress Creek Drainage District, like most in the Delta, was impoverished by the flood that year. Repair work was not done. Years drifted by, and development of the area proved to be as sluggish as its drainage. Eventually a more receptive Congress, with a broader view of flood control, recognized that the improvement of such man-made laterals was a flood-control measure (and a Federal responsibility as well), and the Vicksburg Engineers were authorized to complete work the old drainage boards had attempted.

By the early 1960's, the area was draining with the long hoped-for efficiency. Following the plan first conceived by the drainage districts, the Vicksburg Engineers routed the excess water down the canals to Ditch Bayou and Lake Chicot, which was viewed as a natural flood-control device since it was able to take in a lot of water but release it in a controlled amount at its lower end.

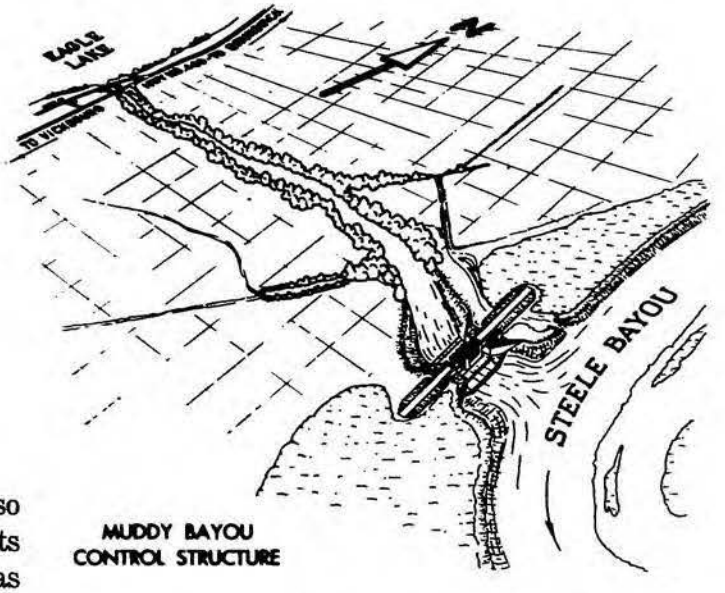
Public response to the completed work was overwhelming. The area developed at an unprecedented rate. However, the increased agricultural use of the region's lands brought new problems. Silt and pesticide, along with the excess water, flowed down the canals into

Lake Chicot's different water coloration is emphasized by the dam which divides the muddy and clear parts of the lake

Lake Chicot. The lake muddied; its turbidity killed much of its aquatic life. Only the portion of the lake which had been dammed off by the State of Arkansas for use as a state park remained clear enough to support desirable marine life.

The Vicksburg Engineers again studied the region in response to public and congressional requests, and a project was designed to divert the drainage flows into the Mississippi instead of the lake. With the passage of the Flood Control Act of 1968, Congress authorized the proposed plan, and the District's Engineers initiated the construction of a double-faceted design: (1) gravity-controlled drainage channels with regulating gates connect the old canals to the Mississippi; and (2) a mammoth pumping plant capable of pumping 6500 feet per second of excess water into the Mississippi (before it reaches Lake Chicot) in periods when the Mississippi is so high that water will not flow by gravity through the gates. The Lake Chicot Pumping Plant, when completed, will offer a bonus to sportsmen aside from clear water: lake levels can now be manipulated for optimum fish and wildlife and other benefits.

Across the Mississippi River, a somewhat similar problem has arisen in recent years.



Eagle Lake, just above Vicksburg, has also been a popular attraction for sportsmen; its fish and waterfowl population in the past has been legendary. It too was an oxbow lake and was flooded each year by water from the Mississippi that kept the oxbow fresh and alive. In the construction of flood improvement works, Eagle Lake was virtually cut off from the main stem. Since that time, its water supply has been largely from Steele Bayou, which flows downstream through Muddy Bayou before entering the lake. Again in this case, the vast amount of agricultural runoff, which Steele Bayou collects, was polluted with pesticides. As these chemicals were drawn into Eagle Lake, fishing declined.

In response to public demands, Congress authorized the Vicksburg Engineers to develop a corrective measure. The Engineers complied, and the project design they developed not only rectified the current problem but provided improvements as well.

The Muddy Bayou Control Structure only a few months from completion

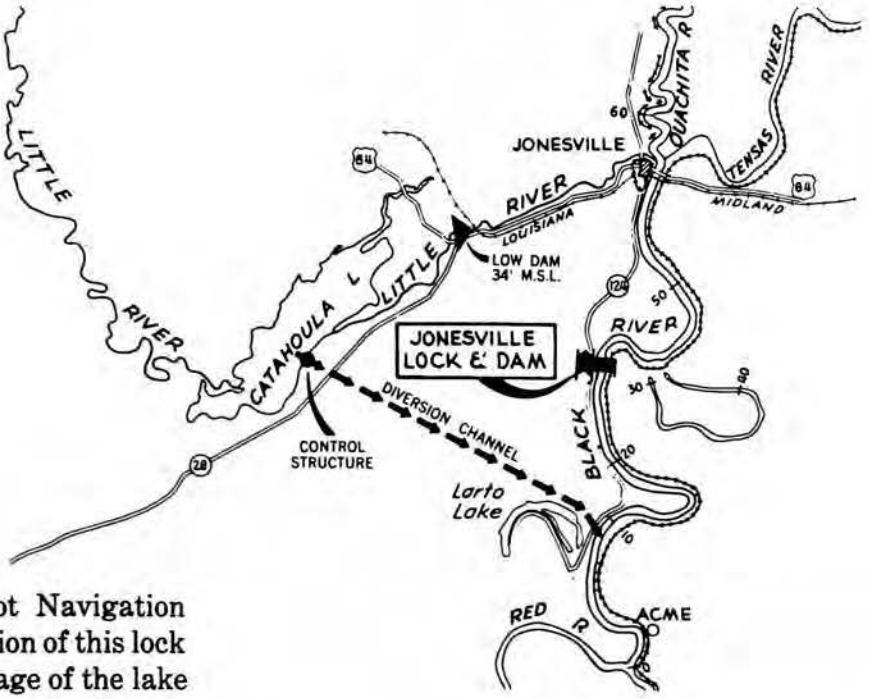
One control structure between Eagle Lake and Steele Bayou now completely blocks water from Steele Bayou (except in extreme high water such as that which occurred in 1973). During periods when the bayou is relatively clear, a freshwater supply can be let into the lake.

This ability to regulate the water level provides two extra benefits as well: fish management and weed control. Optimum fishing is achieved when water level is high in the spring; the increased space generates spawning and growth. In the late summer and fall the water level can be reduced, thereby confining the fish to a smaller area of water and controlling the supply of trash fish. The lower water in fall and winter also exposes weeds in the cold, freezing period and provides a great measure of weed control within this favored lake.

One of the most controversial mitigation or rectification projects in which the District has been involved since the passage of NEPA has been the Catahoula Lake Project. More of a "natural depression" than a lake, Catahoula is very low, very shallow. Historically, it has almost emptied each fall and stayed drained until spring. During that time, a special nut grass called chufa proliferated in the drained area. Wild hogs rooted the ground, and the uprooted nuts attracted migratory mallards and pintails. The center area produced millet and aquatic life for the teal on their way to Mexico. The natural cycle of emptying and filling made Catahoula Lake a favorite resting and feeding spot for migratory birds using the Mississippi Flyway.

In 1972 the Vicksburg District completed the nearby Jonesville Lock and Dam, a vital

Catahoula Lake in Louisiana and water level control structure



feature of the Ouachita 9-Foot Navigation Project. However, the construction of this lock and dam would block the drainage of the lake and cause it to remain at a high level year-round. In the early planning stage the Engineers recognized the problem and studied the best methods to employ to preserve the natural conditions of one of the area's favorite wildlife habitats.

Restoration of the ecological balance, while maintaining the navigation and flood-control improvements, proved to be neither simple nor inexpensive. As a mitigation feature of the lock and dam project, the District excavated a drainage channel of considerable length costing $9 million and equipped it with a control structure to regulate drain and fill. Through this mitigation work, Catahoula Lake has actually been improved over its previous condition as the drain and fill cycle can at times be aided by man, whenever nature needs an assist. The result is an obvious boon to wildlife interests.

The Felsenthal, Lake Chicot, Eagle Lake, and Catahoula Lake Projects all exemplify two kinds of mitigation with which the District is now involved: land reservation and structural mitigation. All projects within the District now contain some type of mitigation feature; some are similar to those already cited, others feature weirs or the leveeing off of green-tree reservoirs. In response to the recognized need of preserving nature's delicate balance, it is anticipated that all projects executed by the District will incorporate mitigation to some degree, either the setting aside of lands or the erection of a structural feature to preserve the natural habitats of fish and wildlife.

Adoption of the mitigation policy is not a panacea for the ills of all elements in society, however. To many in the timber industry, for instance, land mitigation is proposed anathema. Lumber and paper mills are absolutely dependent upon those large tracts of lowlands, the green tree belts that ecologists want to preserve. An obvious compromise must be reached between these two segments of society; alternative means of economic survival must be found for those vitally dependent upon those tracts. "We are going to have to do more and more in the structural area," a District administrator points out, "and this means we'll have to spend more money—which means, in turn, that proposed projects will have to produce more benefits or they will be rejected by Congress as not worth the cost." Again, the Engineers of the Vicksburg District are faced with the necessity of weighing each human value against all others in search of the optimum balance.

The Lower Mississippi Valley as seen by satellite. Note the white area which represents the cleared Delta. Dark spots mark the few remaining forest areas

HYDROELECTRIC POWER

One of the key aspects of the Corps' new and expanding mission has been its involvement in the production of hydroelectric power. With the submission of its 308 Reports to Congress in the wake of the 1927 flood, the Corps focused considerable attention upon the vast power potential of the Nation's water resources and publicly committed itself to the realization of this potential. The passage by Congress of the Flood Control Act of 1936 made this commitment a national policy. From that date, the Corps has been authorized to consider hydroelectric power as a planned purpose (but not an exclusive purpose) in every proposed project.

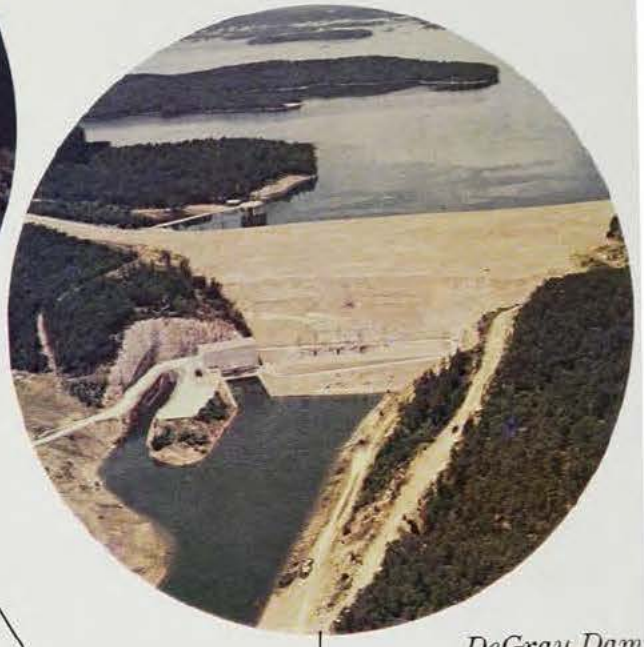
The Vicksburg District was already engaged in the planning and construction of dams and reservoirs when the new Congressional ruling of 1936 was issued. However, the early dams within the District had been designed with little "head"; hydroelectric power at those sites was out of the question. Toward the end of World War II, the District received its first authorization for the construction of a multipurpose facility when authorization for construction of Narrows Dam in southwest Arkansas was modified to permit the added construction of a power plant.

In 1947, at a strategic site in Pike County, construction began on this first project in the District with hydroelectric power. By 1950 the concrete-gravity dam, reservoir, and power plant was a reality, and a relative rarity. Indeed, it is said to have been only the fifth project with hydroelectric power ever constructed by the Army Engineers. Over the years since its completion, however, as the power needs of the Nation have grown beyond prediction, the original plant at Narrows has been dwarfed by the hydroplants that followed it. To keep apace of the growing demands, an additional generator has been added, boosting Narrows' capability to 25,500 kilowatts generated from a storage pool of 410,000 acre-feet of water.

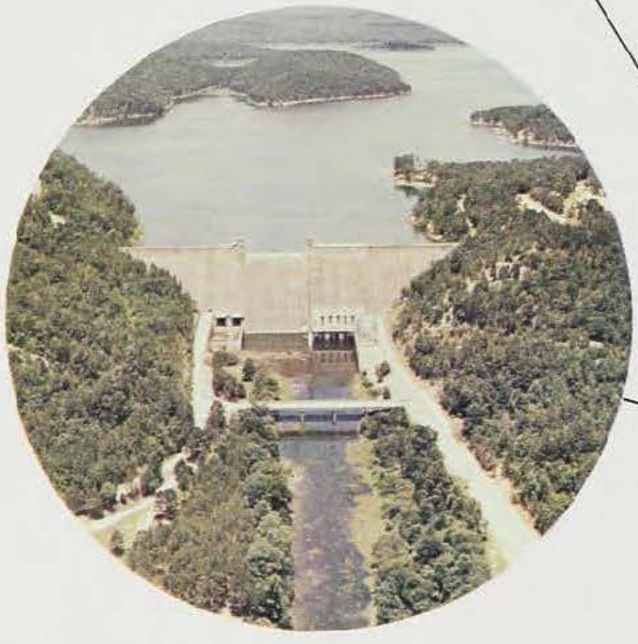
While work was still under way at Narrows, plans were being formulated for a second large power and flood-control dam in the District. Blakely Mountain Dam, on the Ouachita River, completed in 1955, is an earth-fill dam providing a lake with a gross fill capacity of 2.7 million acre-feet and a power plant with a generating capacity of 75,000 kilowatts. In addition, this dam improved the output of two Arkansas Power and Light Company dams below it on the Ouachita by providing them with a more constant water supply. In its construction, Blakely Dam was unique; during the first 2 years of construction work, it was designed to be overtopped, as its 19-foot flood tunnel and 30-foot power tunnel could not handle the spring flows. After 2 years of construction, as the lake was filling, the diversions were able to handle the springtime rises.

Six years after the authorization of its first power plant, the Vicksburg Engineers received authorization to construct an even more sophisticated hydroelectric power plant in southern Arkansas. For one citizen of this region, the authorization was also the fulfillment of a life-long dream. Decades before, an old-time steamboat captain, Flavius Carpenter, had developed an idea for the production of hydroelectric power at a promising spot on the Caddo River, about 8 miles above its juncture with the Ouachita.

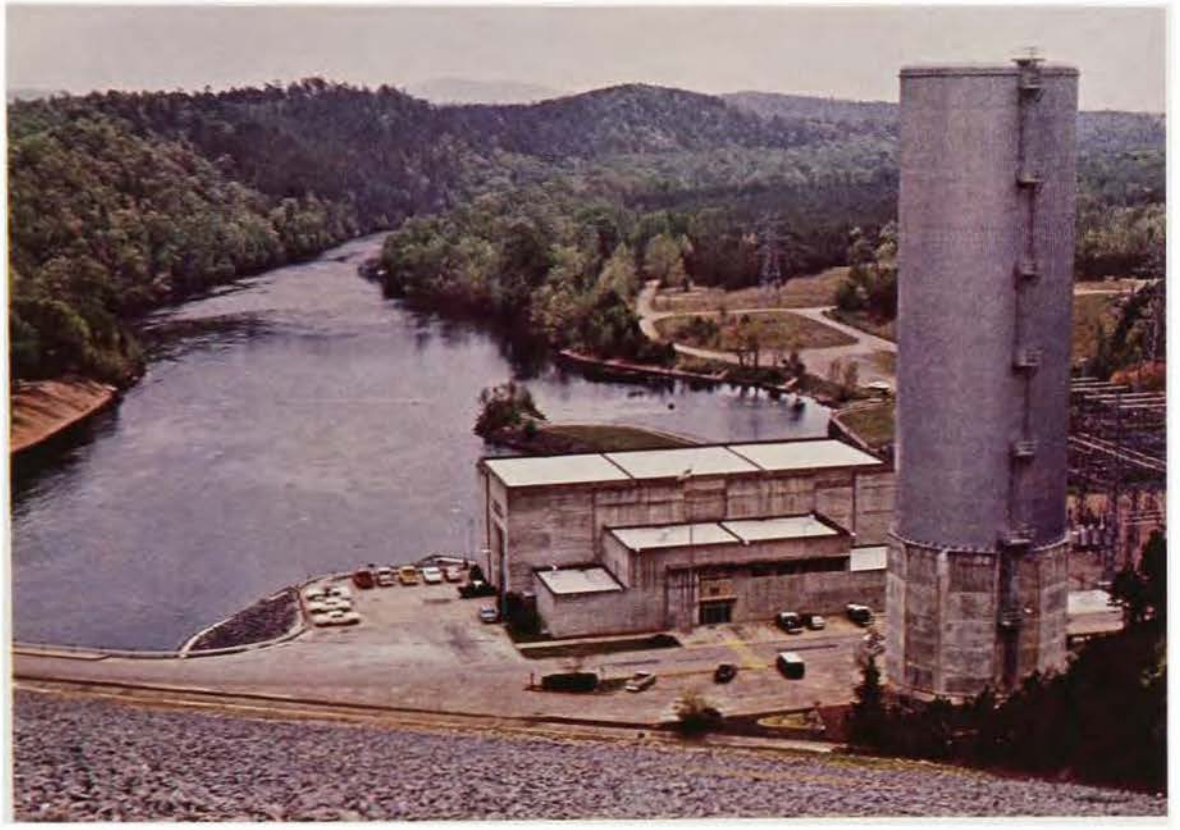
Blakely Mountain Dam



DeGray Dam



Narrows Dam



The power plant at Blakely Mountain Dam, Ouachita River

Carpenter had succeeded in selling his plan to the founder of the Arkansas Power and Light Company, and the corporation acquired the site. Yet, the power officials later abandoned the project in favor of steam-generating plants that offered greater investment opportunities.

In 1942, Vicksburg's District Engineer, Colonel Ray Sauer, was persuaded by interested area citizens to visit the site. Fatefully, the largest Caddo River flood on record occurred the night of his visit. Sauer was convinced not only that the area needed flood control but also that it possessed excellent potential for power generation. After a detailed economic analysis of a plan of control and development for the Caddo, Sauer submitted a project proposal for the construction of a reservoir and power plant subsequently approved by Congress. But, it was not immediately funded.

It was 1950 before the Vicksburg Engineers were at last allotted the necessary

Ray W. Sauer

George F. Dixon, Jr.

appropriations and given authority to proceed with the extensive preparatory studies that were needed. Before the completion of the planning stage, the Korean War erupted, and the project again was shelved. When Vicksburg's District Engineer of that period, Lieutenant Colonel G. F. Dixon, Jr., announced the postponement of construction, he was bombarded with complaints from disappointed citizens. One supporter of the project angrily demanded to know how a colonel could circumvent the will of Congress. "I don't know how a colonel can do that," Dixon responded. "But I got [sic] a four-star general in Washington who says he's President of the United States, and he gives me my orders."

Throughout the next 5 years, the Vicksburg Engineers and the Ouachita Valley residents joined forces with two of Arkansas' leading statesmen, Congressman Oren Harris and Senator John McClellan, to make the project a reality. Much of their battle was won when Congress passed the Water Supply Act of 1958 which greatly enhanced the cost-benefit ratio of the proposed project. Under the terms of this act, municipal and industrial water supply could be included as a project purpose wherever local interests furnished assurance that they would purchase and market water from the allotted supply. By 1959 Congress had appropriated $150,000 for updated planning of the project, and in 1961 the first construction funds were allotted.

Actual construction work on the long-sought project, DeGray Dam and Reservoir, began in 1963. While almost all of the dams in the Vicksburg District have various small unusual features, DeGray has been developed from a unique design of considerable value, a pump storage system unprecedented in the Corps.

Two separate lakes are incorporated into the DeGray design, a large upper lake and a smaller lower one that holds water of a certain capacity. As power is needed and generated during the day, a portion of the used water is released downstream for users there and to

Early construction at DeGray Dam on the Caddo River

The reregulation dam at DeGray Dam, a major component in DeGray's pumpback feature

maintain river flow necessary to sustain a fishery. The balance of the used water is stored in the smaller lake. At night, after power demand drop, one of the generating turbines can be reversed to become a pump which picks up the used water and returns it to the reservoir. On the following day, as demand rises, the cycle begins again.

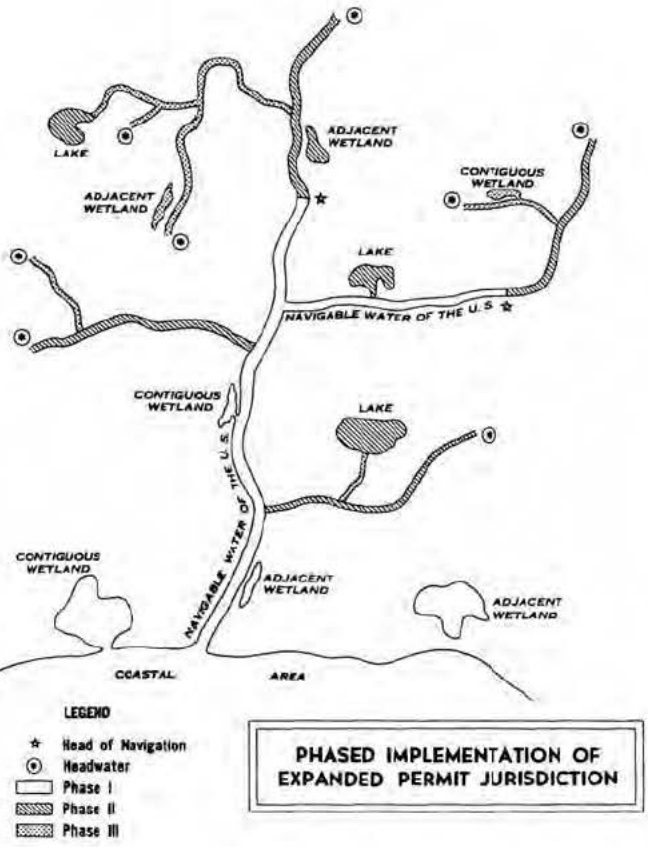
From an economic standpoint, the pump storage design has special benefits. Industry depending upon DeGray's hydropower can rest assured that power will be there in the peak periods of their needs and that it will be sufficient to their needs. For the power plant, which charges the customary extra demand rate for excessive industrial use during peak periods, the pump storage design provides economical and almost instant dormant energy to fill those peak needs.

Efficiency in the operation of the DeGray Dam and Power Plant, and the Narrows Dam facility as well, has been increased through the recent construction of an additional feature in the District's hydropower projects. DeGray Power Plant and Narrows Power Plant are remotely controlled from Blakely Power Plant, thereby reducing the operating manpower requirement at DeGray and Narrows by two-thirds.

WATER RESOURCE MANAGEMENT

For a quarter of a century or more, water resource management has been a rapidly expanding concept of the District's new mission. The prudent and farsighted use of available water supplies had been a fundamental requisite in all Corps work for several decades, but the responsibilities charged to the District in this subject area go far past that point. Increasingly, the Vicksburg Engineers have been instructed by Congress to assume leadership in the areas of water resource research, resource feasibility studies, and resource management.

The permit program within the Corps is an old one. The Refuse Act of 1899 (Section 13 of the River and Harbor Act of 3 March 1899) required the Corps of Engineers to assess and rule upon any proposed obstructions in



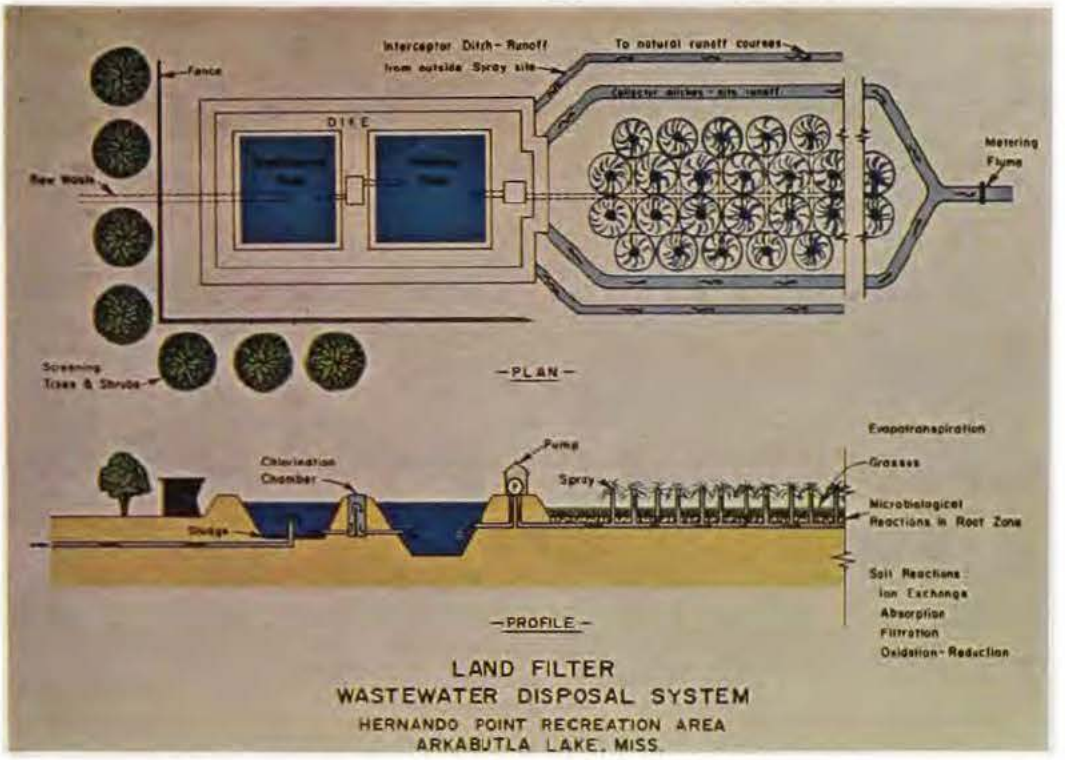
navigable waterways of the United States. But requests for permits from the private sector under this act have been rare. Within the District, years passed which saw the issuance of only two to three permits; in a busy year, there were sometimes ten. The basic concern of this act, of course, was the preservation of unhindered navigation.

The National Environmental Policy Act of 1969, the Water Quality Improvement Act of 1970, and the Federal Water Pollution Control Act Amendments of 1972 extended somewhat the responsibility of the Corps and took the environmental issue into concern as well. Under these new acts, the placement of any fill material or the discharge of dredged material in any of the Nation's navigable waterways requires a Corps permit. Still, environmentalists have insisted that even stronger supervision is needed, and subsequent legal action has generated a recent court decision, extending the Corps' permit program into all of the Nation's waterways and even the low-lying wetlands.

The potential impact of this program is tremendous. In the years between 1899 and 1972, only 1 to 1-1/2 man-years were required within the Corps to handle the permit requests. The proposed regulations will balloon that manpower force to a staff of 3000 at an estimated expense of $35 to $40 million annually. Moreover, the decisions rendered by the Corps on many permit requests will be based on a tremendous number of controversial variables—many of which will undoubtedly have to be settled in the courts. Even the selection of qualified areas will require complex statistical policies and exceptions. In the valley of the Mississippi, where whole counties or parishes (such as Catahoula Parish, Louisiana) are classed as a wetland or lie below the ordinary high-water mark, the potential problems are exceedingly great.

In the area of water resources research and pollution abatement, the Vicksburg Engineers have been engaged in the development of a new wastewater disposal system which employs techniques far in advance of those currently used within the region. Experimentation and construction to date promise a system which will achieve and maintain a high degree of purity in treated wastewater.

The basic principle used by the District is not entirely new. As early as the 1800's, experiments with on-land treatment of wastewater were being conducted in America, but it never gained popularity because of public "hangups" and misunderstandings. Inevitably, as other nations of the world adapted variations of this system and employed them successfully, America's



sanitation engineers cautiously reappraised the old idea and began to experiment with various means of adapting it to modern American needs.

Again, the Vicksburg Engineers are at the forefront of the new movement. At Hernando Point Recreation Area, a Federal facility in north Mississippi, the District's new wastewater disposal system incorporates four basic features. Initially, raw wastes flow into a stabilization pond (comparable to the sewage lagoon or oxidation pond, the most ordinary means of sewage treatment employed in Mississippi's smaller towns). Within the pond, the sewage is treated by natural biological action. Effluent then passes through a chlorine chamber that destroys most of the bacteria not removed within the pond. From the chlorine chamber, the treated effluent flows into a storage pond, and afterwards is periodically sprayed (when weather and soil conditions are favorable) over a 5-acre land filter field. At this point, the land acts as a "living filter," removes all remaining bacterial, toxic, or heavy metallic substances, and any residual viruses.

The advantages of the new wastewater disposal system are numerous. There is no possibility of groundwater or river pollution. In fact, the prevention of this type of pollution, which frequently occurs with traditional disposal methods, has been the primary purpose for the adaptation of the new treatment procedure. Moreover, the process converts many pollutants such as nitrogen and phosphorus into plant-building materials. Excess water can be collected and recycled, even for drinking. Moreover, treatment plants of this nature have no built-in limitation; unlike many conventional plants, they can be enlarged as necessary to handle increasing amounts of sewage.

Adoption of the new wastewater disposal system by the Vicksburg Engineers reflects growing concern over water conservation. The recycling of wastewater nationwide could considerably allay some of the Nation's growing problems with water supply. The reservoir projects constructed throughout the District aided considerably communities with dropping water tables, and may provide a basis for irrigation of arid lands in the Southwest.

As early as 1956, the Chief of Engineers (and former District Engineer at Vicksburg),

The Mississippi River Commission, located across the street from the Vicksburg District headquarters, now can converse with weather satellites via this radio system

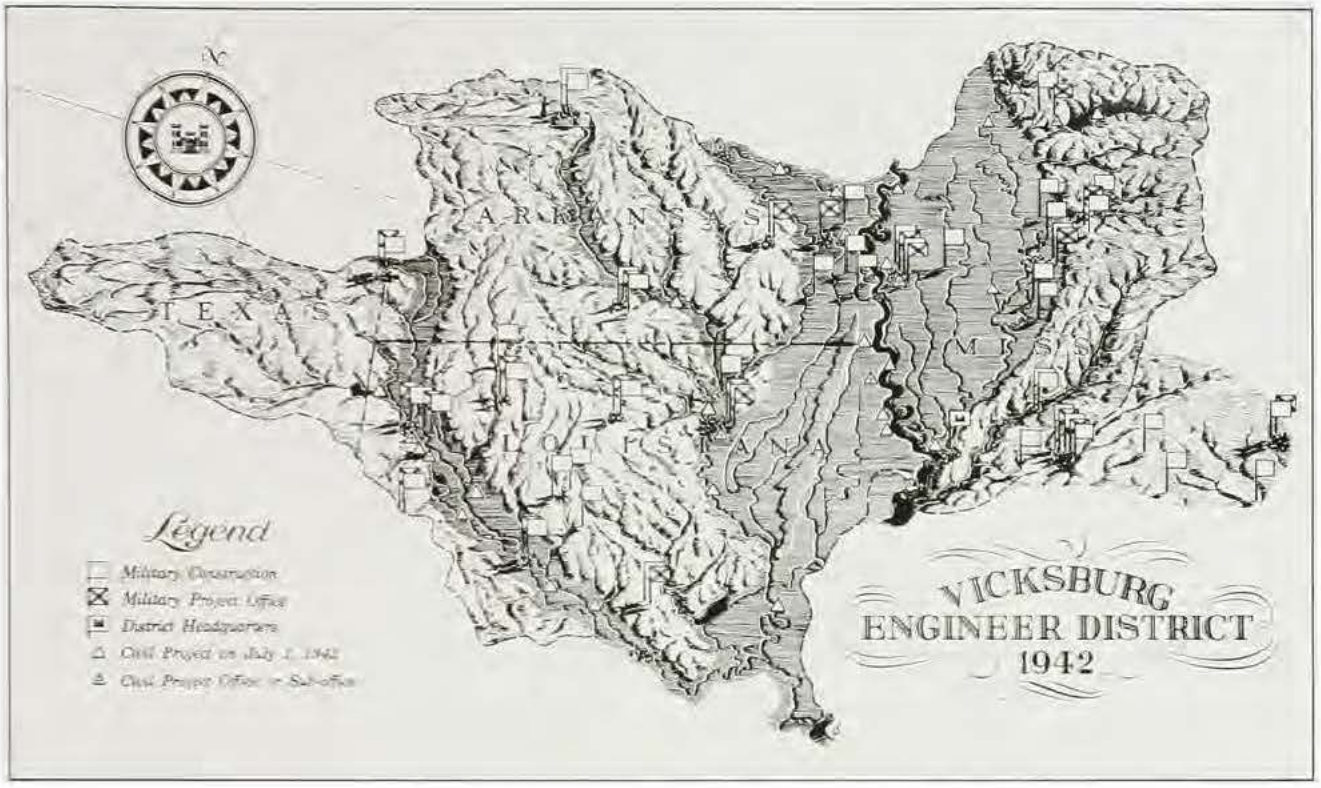
Lieutenant General Samuel D. Sturgis, Jr., warned the Nation that it vitally needed a comprehensive policy for water management, and that it was rapidly running out of time. National consumption of 40 billion gallons of water daily in 1900, mushroomed to an estimated daily average of 453 billion gallons in 1975. By contrast, the annual rainfall in the Nation produces 4300 billion gallons daily, of which only 1300 billion is available for consumption. Already America is said to have reached the point that it is consuming one-third of its finite limit, and many arid areas have advanced dangerously past that point.

Within the Vicksburg District, an exhaustive study has already been made, at the request of the Mississippi River Commission and in conjunction with other agencies, on the possibility of piping valley floodwater to the high plains of the Southwest. Basically, the study was to determine whether surplus water now exists and will exist in the future for this purpose. The results of the study were both interesting and disappointing. Although the Mississippi Valley is historically a floodplain, it still holds little excess water in those periods of the year when water is most needed in the north Texas-Oklahoma region. While more than enough surplus water exists during the valley's flood season, the storage of that water until needed would require reservoirs of unprecedented and almost inconceivable size—and an astronomical amount of public financing. Funds to accomplish such a task do not exist. Yet an urgent need remains.

"Today we play a brand new ball game," Colonel John Brennan warned a Monroe audience during his tenure at Vicksburg. "Water, in the right place, at the right time, sufficient and adequate in quality, is taken for granted by millions of Americans—until the supply fails." The key to preventing such a calamity lies in three factors, as Brennan pointed out: a comprehensive plan, technological competence, and public cooperation. Vicksburg's modern engineers have made great strides in the first two areas and constantly work toward the latter, with a sincerity that has earned them praise even from long-time foes.

THE WAR EMERGENCY

The ability of Vicksburg's Engineers to respond and adapt to public needs, on an emergency as well as long-range basis, has been evident throughout their history. In wartime or peacetime crises, the Army Engineers within this District and their civilian employees have consistently risen to the emergency and often performed far above expectations.



The First World War barely affected the Vicksburg Engineers, aside from the resulting shortage of men, supplies, and money. World War II presented the Nation with a crisis of much greater immensity, and the role of the Vicksburg Engineers shifted decisively from Civil Works to military defense projects. Indeed, America's eminent General Douglas McArthur summed up this second world conflict as an "engineer's war." At Vicksburg, the Army Engineers and their civilian staff adapted to the new responsibilities and their inherent challenges with commendable alacrity, competence, and ingenuity.

Early in the conflict, the United States Army Corps of Engineers was assigned responsibility for military construction on the home front. Within each district, bases were required for training a multitude of raw recruits; munitions and ordnance plants had to be constructed where civilians clustered in ample numbers to man them. The various military branches of the government needed airfields and hospitals and depots.

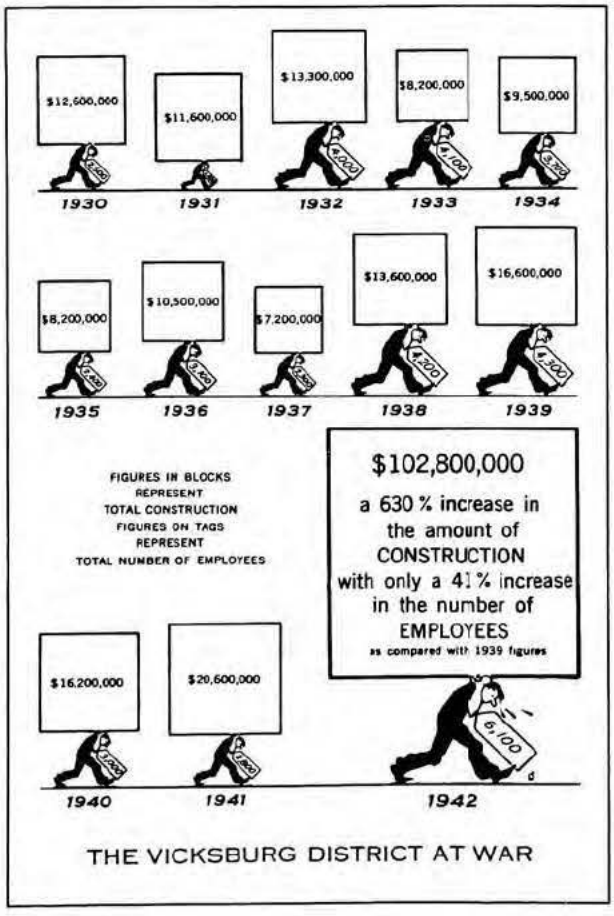
In the face of this emergency, the Vicksburg Engineers ploughed into construction activities on a basis that exceeded all previous experience. Throughout much of Louisiana, Mississippi, and Arkansas, the Engineers were dispatched to locate suitable spots for each type of facility. Supply routes, soil formations, population density, and natural resources all had to be assessed carefully and immediately. Sites had to be purchased and right-of-way problems settled swiftly, yet with economy.

A host of problems arose with every activity, in every locality. Labor was in extremely short supply, particularly in the cotton-growing region surrounding Vicksburg. Construction work in the District skyrocketed from an average of $10 to $12 million annually to an annual range of $60 to $100 million during the war years, an increase of 500 percent or so. Yet, the District Engineer, Colonel Sturgis, was able to increase his personnel only by 55 percent.

Ambitious military commanders made

Engineer troops' camp near Pine Bluff, Arkansas, May 1943

absurd and often impossible demands at numerous construction sites. The commander of Key Field at Meridian, Mississippi, for example, was not content to conduct an efficient training school for 2000 airmen, but insisted that his base must be the "best Air Corps Cantonment in the United States," and



the commander was referring to facilities as well as skill. Other military commanders insisted upon locating bases at swamp sites—or airstrips so weak that the wheels of heavy planes "cut through it like a knife."

Civilian contractors frequently balked at decisions made by Sturgis. Indeed, the District Engineer later described the most serious problems faced by his constructing quartermasters as "obedience from the contractor. Make a decision he does not like," Sturgis bemoaned, "and off he flies to Washington, not only to get your decision reversed, but sometimes to get you fired." Bureaucratic military leaders, moreover, insisted upon a centralized real estate office in Washington to handle site purchases. Their representatives, unacquainted with area customs and attitudes, frequently antagonized local residents and made the District's tasks more difficult.

The centralized purchasing policy of the wartime army posed particular problems. Supplies and materials were frequently unavailable when needed. At one point, two separate projects under Sturgis' direction, an ammunition plant at El Dorado, Arkansas, and an Air Force training site at Monroe, were stymied for want of cast iron pipe. The Air Force exerted considerable pressure upon production authorities in Washington and succeeded in obtaining the promise of pipe for

Sturgis to use at the training base. But, the ammunition plant was equally vital; and so, the District Engineer spent a day on the telephone with Washington, finally eliciting the verbal promise of pipe for the El Dorado site. Before night, his promise was confirmed by telegraph—and then a second telegraph arrived: "Priority recently granted Monroe Air Corps Base for cast iron pipe disapproved since this pipe is needed for the El Dorado Ordnance Plant."

Yet, in the midst of their problems, there were boons for the Vicksburg Engineers. Military forces in Europe eventually were laden with large inventories of recaptured equipment, much more than they could maintain. With innovative practicality, Colonel Sturgis contacted the Chief of Engineers, Lieutenant General Eugene Reybold, and suggested that this pool of equipment be distributed to division headquarters. By spring 1942, Sturgis had a mammoth repair shop in operation in his District, rebuilding and overhauling his worn out machinery.

HIGH-WATER FIGHTS

The war emergency required the postponement of most civil projects in which the District was involved. Yet, it was occasionally preempted by civil crises such as the flood fight of 1945 that demanded immediate relief. Heavy rains began early in February of that year and continued until April. All of the major tributaries of the lower Mississippi swelled to bank-full stage and spilled over in many areas.

The Vicksburg District mobilized at the first sign of the impending danger. By the time the first levee was endangered, the flood fight was already organized. Working in cooperation with local levee boards, state militia, private citizens, public transportation and communication interests, and various technical branches of the United States military forces, the Vicksburg District assumed responsibility for all administration and personnel, as well as their subsistence and nontechnical supplies.

In the face of a severe shortage of labor, prisoners of war (POW) from area camps were pressed into service. By April 12, over 3800 POW's stood ready in the District, and shelter had to be provided by the Engineers for each of these. Too, careful rules had to be observed in their employment to comply with international humane standards as well as to prevent possible sabotage—or even the fear of sabotage among a nervous public. No POW could be asked to work more than 12 hours per day, except in the gravest emergency, and no POW's could be placed under the supervision of blacks. Above all, fraternization with the POW's was strictly prohibited.

From Petacocowa Creek in the Yazoo Valley to the uppermost navigable reaches of Red River, the Vicksburg District was called into action by desperate citizens, levee boards, and local governing bodies. Railroads and highways washed out; engineers closed the gaps. Bridge spans collapsed, and temporary bridges were built to keep transportation routes open. Levees had to be sandbagged throughout the District; many of them crevassed and had to be repaired or supported by hastily built auxiliary levees.

Engineer troops placing sandbags around sand boils in the dense junglelike underbrush on Arkansas River levees

Floodwaters test a levee on the Mississippi with the flood taking the prize in most overtoppings

Whole towns were exacuated or cut off by floodwaters, from Calion, Arkansas, to Jefferson, Texas. Emergency ring levees were built around other towns, often with Corps assistance. At Jonesville, Louisiana, such an effort was under way, with women providing 50 percent of the labor, when the Vicksburg Engineers arrived with POW labor to complete the project. Along Bayou Bartholomew, above Monroe, the local levee board gave up the fight entirely and beseeched the Corps to assume the work. Draglines from the Vicksburg Office were placed on the job immediately, and within a week 4-1/2 miles of emergency levee were constructed entirely at government expense.

Continued rainfall deluged the upper Red River. Over 12 inches were recorded at Naples, Texas, between March 29 and April 2. As the floods washed downriver into north central Louisiana, it was increasingly obvious that a major fight was at hand, particularly in the Cane River Levee District of Natchitoches Parish. Local interests there procured 150 Negro troops from nearby Camp Livingston to hold the levee near Aloha, Louisiana; the troops gave up the fight within 3 hours. POW's were moved in, but still the levees crevassed. Over 90,000 acres of alluvial farmland were flooded, and five persons drowned in the course of the fight.

The flood fight of 1945 was not the last in which the Vicksburg District was called into action. The increased protection provided by the Corps flood-control works did considerably reduce the occurrence of flooding—and the severity of damages suffered—but it could not curtail it. Simulated flood fights have been held annually at Vicksburg to keep the Engineers in a state of preparedness, and the skills they have maintained have been put to use in many emergencies.

Of the flood emergencies which have involved the Vicksburg District, the flood fight of 1973 was by far the most significant. More labor—and more funds—were expended in the course of that emergency than in the major flood fights of 1927, 1937, and 1945 combined. More technological innovations were utilized than ever before, in materials as well as methodology. Estimated losses within the District were tremendous ($335 million) but estimated losses prevented within the District were far greater ($4.4 billion).

In the fall of 1972, weather conditions in the Vicksburg District became unusually severe, worse than many area residents could recall. Freezing rain in record-setting quantity, tornadoes, and driving sleet and snow all deluged the lower Mississippi Valley and continued month after month. Engineers and meteorologists who were familiar with the 100-year and 1000-year weather cycles had already labelled the 1927 flood as "the worst of the century," but none could venture a guess as to when the "thousand-year flood" would strike. Many since have applied that label to the water levels of 1973.

On the night of 15 March 1973, the District office received a call for help from the mayor of Greenwood. An 8-inch rain fell on his city that night. The Corps levees built there years before were holding against the tremendous pressure, but urban development had sprawled far outside their protection. Nearby levees built by local interests along Big Sand and Pelucia Creeks did not hold. The confined waters boiled from those creeks into the Yazoo and washed over the new subdivisions.

Marvin W. Rees

An area engineer of the District was already on the scene. and he confirmed the plight that the mayor had described. Colonel Marvin W. Rees, the District Engineer, responded immediately, giving orders to cut the earthen plug that dammed the old Fort Pemberton Cutoff—not with dynamite as most flood stories dramatically portray such situations but with an ordinary dragline, the most efficient means in existence. By three the following afternoon, a sufficient gap had been dug to wash away the remainder of the plug. Much of the Yazoo River then bypassed Greenwood and eased considerably that city's woes. The flood fight was off to a prophetically successful start.

In the weeks that followed, Corps personnel were dispatched throughout the Yazoo Basin where the greatest flooding in the District was occurring. Nearly 4-1/2 miles of local interest levees in Humphreys County were raised in cooperation with that county's Board of Supervisors. Emergency protection works were constructed in Warren County, the District's home base, as Mississippi River backwater rose ominously. Sandbags were issued in many regions to help protect homes and businesses. Portable, wheel-mounted pumps, powered by farm tractors, were in great demand and were of significant aid to water-logged Greenwood, for example.

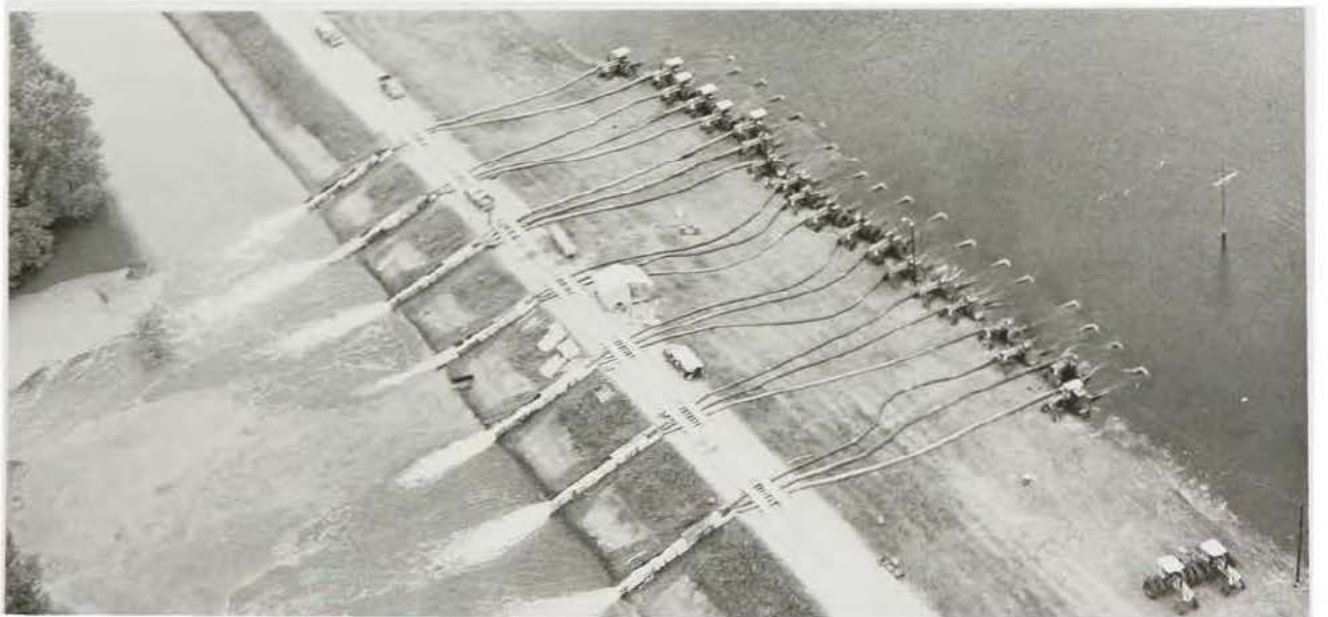
Meanwhile, Mississippi's four reservoirs, key features of her flood-protection program, had filled beyond capacity and were discharging water through their spillways. At three of these reservoirs, the emergency spillways were used for the first time; at the fourth, it was only the second occurrence. An immediate examination by the Hydraulics Section forecast doom: if even a 4-inch rain occurred—common in Mississippi—before the reservoirs attained some storage room, the city of Greenwood would suffer catastrophically.

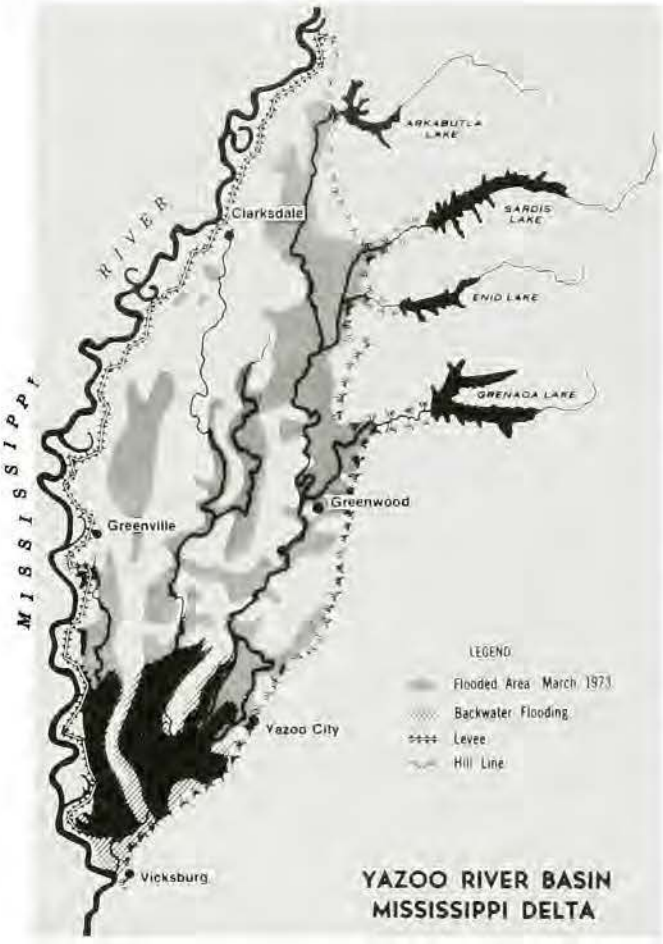
The District's forces responded immediately with emergency work on the 21 miles of levee that protected Greenwood, raising the levees and building plywood flashboards. Plywood was hauled in from all over the country by truckloads, any size or quality the Engineers could obtain. The investment was easy to justify; the economic importance of the city of Greenwood was indisputable, but—in the words of one Corps administrator who was heavily involved in the fight—"we absolutely tore up the plywood market in this region!"

As rains continued that spring, emergency work spread into almost all areas of the District. Indeed, almost every stream within the District's boundaries had risen above or near flood stage. Emergency pumps were shipped to Monroe to reduce flooding within that beleaguered city. At Jonesville, urban development also had sprawled beyond the original protection levees, as it had at Greenwood. By mid-April, a hospital, an airport, an industrial park, and a housing development in the Jonesville area faced a


WELCOME TO GREENWOOD
LEVEE CITY


Patricia
MOTOR
HOTEL
WE ARE PROUD
OF THE
U S CORPS OF ENGS
AND
CONGRESSMAN
OTTO E. PASSMAN
OTTO CARES TOO
HIS RECORD PROVES IT





serious and immediate threat. Together with the Tensas Basin Levee District and the Louisiana State Highway Department, the Corps erected 4-1/2 miles of emergency backup levee to the west of Jonesville. Within days, one old local interest levee was overtopped, but the emergency levee held.

As flooding increased in the Red River Backwater Area, the Bayou Cocodrie floodgate began to leak. At times, the Red itself was more than 10 feet higher than the impounded water, creating terrific pressure problems. Again the Corps raised the levee, for 36 miles in the backwater area. Much of the levee addition consisted of a crown or "potato ridge," 1 to 2 feet high constructed of borrowed material from the backside of the levee. Where no borrow material existed, sandbags were substituted. Polyethylene film was unrolled and affixed to more than 23 miles of these backwater levees to give an added measure of protection. Boosted by the operation of twenty 12- and 16-inch pumps from May 28 to June 21, the Red River backwater fight was a success.

Along the Mississippi River an even greater degree of emergency work was demanded. Nearly 96 miles of main-line levees were raised on the west bank in a period of 14 days to offset the decreased efficiency of the channel. A major sandboil in that levee near the Greenville bridge presented a serious threat that struck notes of fear in the hearts of old timers there who recalled the main-line crevasse near Greenville in 1927. A sandbag ring 28 feet in diameter effectively reduced the head. Yet, after being contained, the boil still discharged 168 gallons of water per minute.

Corps efforts in this emergency were tremendous, but the District did not shoulder the flood fight alone. The postflood report issued at Vicksburg in October of that year recounted many efforts by the private sector and praised the "highly admirable manner" in which they accepted responsibility. "Each turned in stellar performances on almost all phases of the emergency activities for which they were responsible," the report concluded.

OTHER CIVIL EMERGENCIES

The civil assistance works of the Vicksburg Engineers have encompassed a much broader range of activities than mere cooperation in flood fights. The Army Engineers of this District have mobilized for many area emergencies. In tornado-wracked areas, as in the city of Vicksburg itself in 1953, the Engineers have searched collapsed buildings for casualties, provided transportation for rescue workers, evacuees, and supplies, checked out utility lines and cleaned up debris. Their landing mats have moved mobile homes into muddy, impassable areas for homeless families; their sanitary precautions have protected thousands from disaster-related diseases.

The tornado which ravaged Vicksburg in 1953 gave the Engineers. . .

. . . a task of organization and assistance in their own backyard

Crews and equipment bearing the crest of the Vicksburg District were on hand for several days until order was restored

Too, disasters outside of the District have sparked cries for help that were answered by Army Engineers of Vicksburg. Hurricanes Diane and Donna in 1955 and 1960 carried Vicksburg's Engineers to the New England area, and the Gulf Coasts' Hurricane Audrey of 1957, Betsy of 1965, and Camille of 1969 called personnel from the Vicksburg District to western Louisiana and Texas. The Mississippi Engineers were on the scene again when the Missouri River flooded in 1952 and California's Russian River overflowed in 1965. Their missions took them to Alaska after the earthquake of 1964; and the experience they had gained in the recovery of sunken bargeloads of poisonous liquid chlorine at Natchez in 1962 made their services indispensable when a similar but far worse disaster occurred in Baton Rouge in 1965. Indeed, the Vicksburg Engineers have developed a national reputation, not only for their expertise in relieving human suffering during the course of such emergencies but also in the economic recovery of the victims through prompt and precise damage estimates.

An excellent example of the District's expanding mission is its involvement in the national Fallout Shelter Program during the 1960's. Cognizant of the dangers that America's population would face in the event of a nuclear attack, the Office of Civil Defense in 1961 initiated a program to develop shelters that would protect the populace from the deadly effects of nuclear "fallout." The Corps of Engineers was requested to help in this program, and the Vicksburg District was assigned responsibility for certain duties throughout the State of Mississippi. From that year until 1968, when the Mississippi operation was consolidated with that of Alabama under the Mobile District, the Vicksburg Engineers were heavily involved in the Fallout Shelter and Civil Defense programs.

A major responsibility was the identification of extant buildings suitable to serve as shelters. Computerized techniques employed by the District enabled its Engineers to correlate population density statistics with the degree of protection that available shelters could provide in each area.

Also in cooperation with the Office of Civil Defense, a National Attack Warning System and an Emergency Broadcast System were developed to provide instant warning to the Nation in case of nuclear attack and continued broadcasts under such emergency conditions. Across the State of Mississippi, the Vicksburg District equipped several radio stations, chosen by Civil Defense, with a fallout shelter, emergency generator, fuel storage capability, and a minimal amount of broadcasting equipment to enable them to operate in the midst of a nuclear attack. Finally, since public awareness and cooperation is an indispensable part of any emergency operation, the Vicksburg Engineers prepared and disseminated throughout the state a vast number of brochures describing the facilities and services available and instructed the public on courses of action to take in the event of a nuclear emergency.

Corps contractor raises the last of the chlorine barges from the Mississippi, ending a period of fear for Natchez and Vidalia residents

In 1976, the District was called on for tornado cleanup in Canton, Mississippi. Corps forces arrived even before the National Guard and other emergency units, some from as far away as Greenville and Sardis

THE PEOPLE'S ENGINEERS—1976

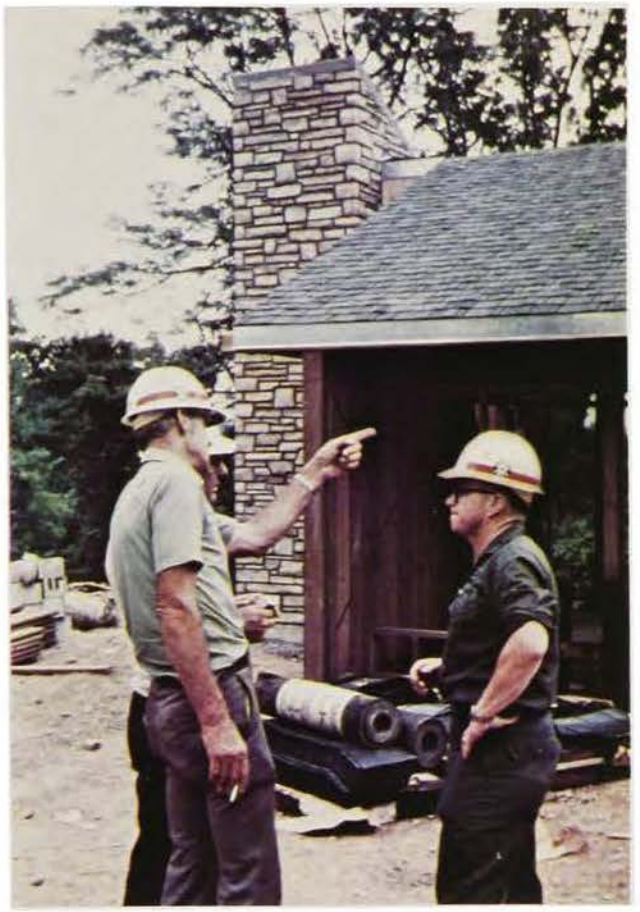
The new and expanding mission of the modern Army Engineers has been forcefully summarized by a recent president of the Mississippi River Commission, Major General Robert G. MacDonnell. "We are in a revolutionary age of explosive change, with tremendous unprecedented demands. Engineers now look...from a broader viewpoint." Yet, today's revolution in water resources development is not so much an overthrow of all former guidelines as it is a reevaluation. Old responsibilities have assumed new complexities; the old solutions are no longer applicable.

The Engineers of the Vicksburg District are meeting their expanding mission with a manpower of unsurpassed size and capability. A fluctuating force of 1500 to 2200 employees, both military officers and civilians, are responsibile for the improvement of some 50,000 square miles of land and waterways. Although much of the District's original territory has been transferred to other agencies over the years, the Vicksburg District remains the largest in the Lower Mississippi Valley Division.

Of those 1500 to 2200 employees, seven are regular engineer officers of the United States Army. The bulk of the force within the District are civil employees. This distribution of

The men and women, professionals and clericals, the GS and WG employees...

... have brought a quality standard of living into the lower Mississippi Valley, the District, and their communities and represent the largest, most complex engineering organization in world—the U. S. Army Corps of Engineers.



manpower is a significant one. District Engineers normally serve an area for only 3 years; their assistant officers may serve only two. The continuing presence of that majority of civilian employees is vital to the continuity of policy, and the degree of efficiency they have achieved is one of the best in the Corps organization.

The impact of Vicksburg's Engineers upon the area that they serve has been obvious, and their labors have earned them sincere plaudits from a grateful public. In tribute, a Vicksburg newspaper has editorialized:

Vicksburg has been and is now, an engineer city. We are blessed with [a litany of specialized] representatives of the far flung profession of engineering.

And all around us the fruits of their knowledge and their know-how are apparent.... We have reason to esteem and respect the professional engineer in our midst.... The engineer has been one of us, through his active and wholehearted participation.

We are proud of our engineer friends and neighbors—proud to have them in our midst—and proud to salute them at this time—in this, the Engineer City.

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INDEX

D

E

F

G

H

I, J

K

L

M

N

O

P, Q

R

S

T

U, V

W

X, Y, Z

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June 1931-Oct 1933

Maj. Clark Kittrell
Oct 1933-Nov 1933

Lt. Col. L. E. Oliver
Nov 1933-June 1937

Lt. Col. R. G. Moses
June 1937-July 1940

Col. S. D. Sturgis, Jr.
Sept 1940-Dec 1942

Lt. Col. R. W. Sauer
Dec 1942-May 1946

Col. Robert G. Lovett
May 1946-May 1949

Col. B. C. Fowlkes
July 1949-Oct 1950

Lt. Col. G. F. Dixon, Jr.
Nov 1950-July 1953

Col. Thomas B. Simpson
July 1953-July 1956

Col. M. P. Barschdorf
July 1956-July 1959

Col. James E. Walsh
59-Dec 1960

Capt. C. J. Cox
Dec 1960-Jan 1961

Col. E. B. Downing
Jan 1961-Mar 1961

Col. Warren S. Everett
Mar 1961-Dec 1963

Maj. William T. King, Jr.
Dec 1963-Jan 1964

Lt. Col. James A. Betts
Jan 1964-Aug 1966

Col. Felix R. Garrett
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